LATE CRETACEOUS AMMONITES FROM THE WADI QENA AREA IN THE EGYPTIAN EASTERN DESERT

by P. LUGER *and* M. GRÖSCHKE

ABSTRACT. Ammonites from several transgressive phases of the late Cenomanian to the late Campanian in the Wadi Qena area (Eastern Desert, Egypt) are described. Taxa included represent mainly Tethyan (south-west European, North African) and rarer Nigerian and Madagascan species. The recognized species belong to the genera *Neolobites*, *Pseudocalycoceras* (early late Cenomanian); *Metengonoceras* (late Cenomanian); *Pseudaspidoceras* (late late Cenomanian); *Nigericeras*, *Vascoceras*, *Thomasites* (late Cenomanian to early Turonian); *Mammites*, *Fagesia* (early Turonian); *Coilopoceras* (late Turonian); *Metatissotia*, *Subtissotia* (middle Coniacian); *Canadoceras*, *Manambolites* (late middle Campanian); *Baculites* (middle and late Campanian); *Libycoceras*, *Nostoceras*, and *Solenoceras* (late Campanian). A correlation of the late Cenomanian to early Turonian ammonite successions of North Africa, the Middle East, and south-west Europe is attempted.

LITTLE effort has been spent on the study of ammonites from the late Cretaceous of central Egypt after a first phase of investigations in the early years of this century (e.g. Eck 1914; Douvillé 1928). The present study benefits from the large quantity of new material collected by members of the Special Research Project 69 'Geoscientific Problems in Arid Areas' of the German Research Foundation during field trips in 1985 and 1986 in the central and southern Wadi Qena. Following detailed investigation of these ammonites, the present paper aims to present the palaeontological evidence for the biostratigraphical attribution of the lithological units in this region (Klitzsch 1986; Hendriks *et al.* 1987; Klitzsch *et al.* 1989), which is a key area for understanding the geological history of the Eastern Desert of Egypt.

Wadi Qena, situated in the central part of the Eastern Desert, is a N.–S. directed depression of approximately 200 km in length, bordered by the Eastern Desert Basement High to the east and an escarpment of Cenomanian to Eocene sediments in the west (text-fig. 1). Due to its cratonal position, its depositional history is characterized by transgressive/regressive cycles, which generally coincide with major eustatic sea-level changes (Luger and Schrank 1987). Therefore, the Cenomanian to Campanian stratigraphic column comprises sediments of continental to shallow marine facies in which the occurrence of ammonites indicates the relative highstand of each transgression from the late Cenomanian to the late Campanian.

The lithostratigraphy of the Wadi Qena area has been described in detail by Klitzsch (1986) and Hendriks *et al.* (1987). A summarized section of the lithological column in the central Wadi Qena is given in text-fig. 2. A combined section of the Campanian at Gebel Qreiya (text-fig. 1) is shown in text-fig. 4.

STRATIGRAPHY

Cenomanian to Turonian

Late Cenomanian–early Turonian. In the Wadi Qena area the first transgression of the southern Tethyan sea is documented by the marine sediments of the Galala Formation, overlying fluvial sandstones of the Wadi Qena Formation above the crystalline basement (see text-fig. 2; Klitzsch 1986; Hendriks *et al.* 1987). The lowermost ammonite horizon in the shallow marine deposits of

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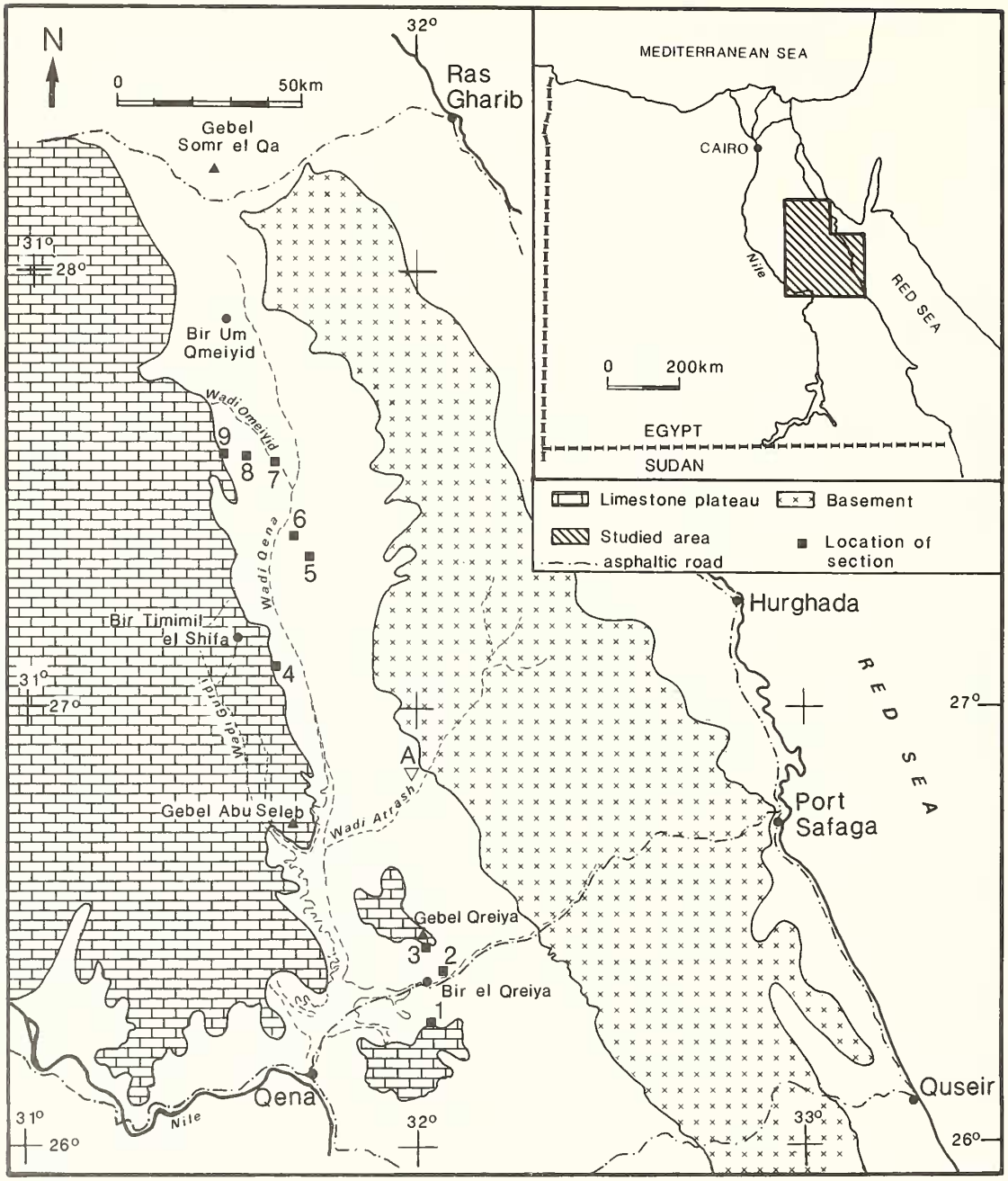
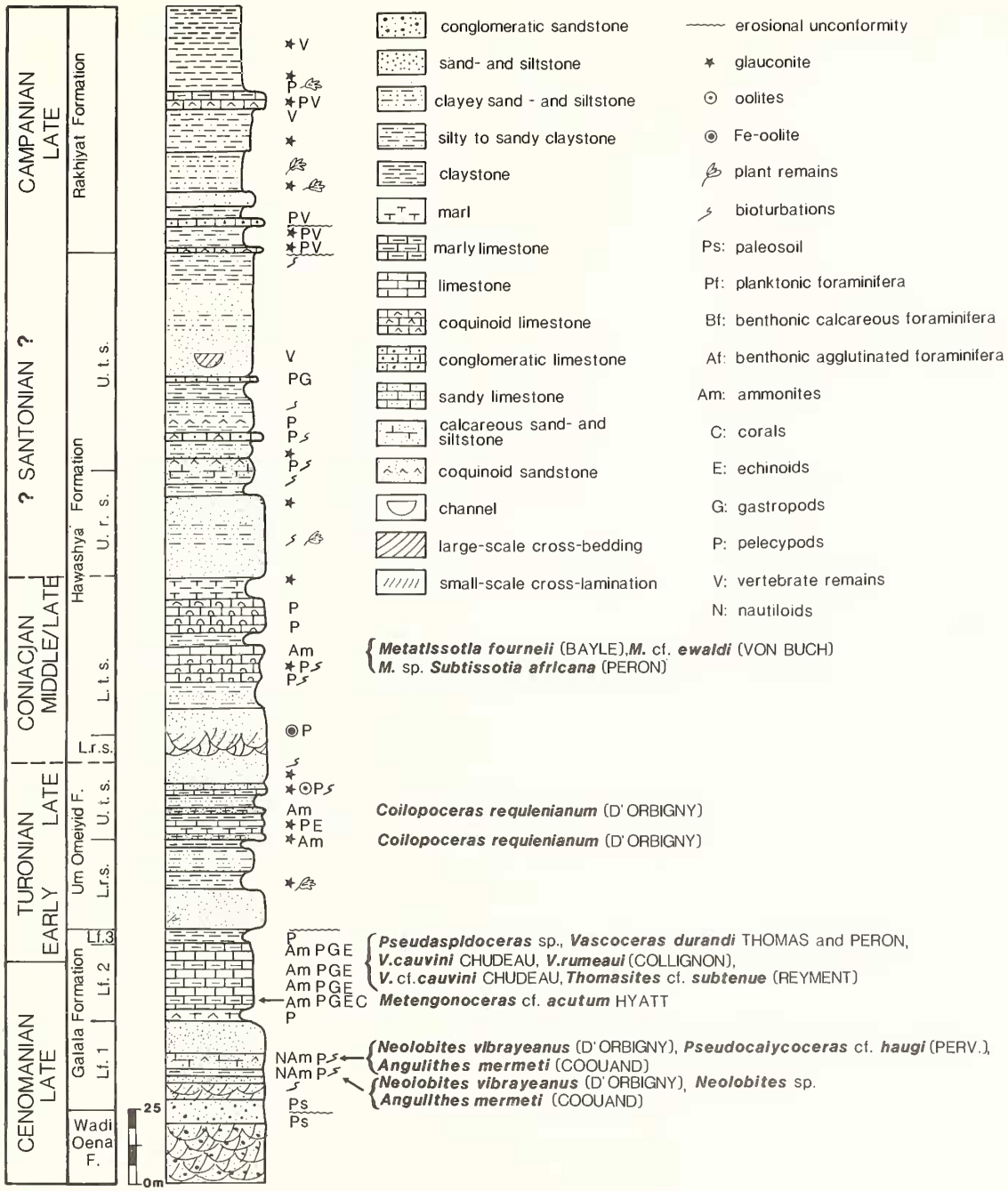


TEXT-FIG. 1. Location of sections 1–9 and Locality A in the Wadi Qena area (see also Hendriks *et al.* 1987; Hendriks and Luger 1987).



TEXT-FIG. 2. Generalized section of late Cretaceous sediments in the central Wadi Qena (sections 7–9 combined, modified after Hendriks *et al.* (1987, fig. 5)). Lf 1–3 = Lithofacies 1–3; L.r.s. = Lower regressive sequence; L.t.s. = Lower transgressive sequence; U.r.s. = Upper regressive sequence; U.t.s. = Upper transgressive sequence.

the lower Galala Formation contains *Neolobites vibrayeanus* (d'Orbigny), *Neolobites* sp. and the nautiloid *Angulithes mermeti* (Coquand). Separated by about 2·5 m of clay-/silt-/limestone intercalations it is overlain by a sandy limestone with *N. vibrayeanus* and *Pseudocalycoceras* cf. *haugi* (Pervinquière), together with *A. mermeti*.

N. vibrayeanus is widely known from the early late Cenomanian prior to the occurrence of *Metoicoceras geslinianum* (d'Orbigny) and *Vascoceras gamai* Choffat of the Middle East, North Africa, and Western Europe (see text-fig. 3). According to Berthou (1984, p. 52) and Berthou *et al.* (1985, p. 56), *N. vibrayeanus* is restricted to the *naviculare* Zone in Portugal. This is also in agreement with the occurrence of *P.* cf. *haugi*, which has been reported from around the boundary of the *crassum* and *naviculare* Zones (Thomel 1972).

The upper part of the Galala Formation is made up of light yellow, massive marls and marly limestones, containing hermatypic corals at the base. The only ammonite found at the base of these marls is *Metengonoceras* cf. *acutum* Hyatt (section 7, see text-fig. 2). *M. acutum* is known from the late Cenomanian *pondi* to *gracile* Zones of the North American Western Interior Basin prior to the occurrence of *V. cauvini* (see Cobban 1987), which is in agreement with the stratigraphic position of the present *M.* cf. *acutum*.

Further up, irregularly distributed ammonites of latest Cenomanian to earliest Turonian age are very common. Due to the massive nature of the sediment, the irregular distribution of ammonites and the severe erosion, most of the ammonites from these layers could not be collected from well-defined horizons, but from talus surfaces. Therefore, as mixing of different faunal assemblages may have occurred, it is impossible to give a well-defined ammonite zonation around the Cenomanian/Turonian boundary in this paper.

Among the present material, *V. gamai* Choffat was found only at localities where the lower parts of the massive marls of the upper Galala Formation are exposed (sections 5 and 6, see text-fig. 1). It was not observed among the assemblage of globose vascoceratids mentioned below. In Portugal, *V. gamai* occurs in the *geslinianum* Zone, although the '*V. gamai* group' ranges into the early Turonian (Berthou 1984, p. 52; Berthou *et al.* 1985, p. 70). A similar situation is reported from Algeria, where a *Neolobites*/*Pseudocalycoceras* assemblage (Zone II) occurs prior to *V. gamai* (Zone III), which itself is followed by a *Wrightoceras*/*Banchioceras* assemblage (Zone IV), the latter being replaced by the vascoceratid assemblage of Zone V (Amard *et al.* 1981, table 5), see below. Therefore, we assume the same stratigraphic position for the Egyptian specimens of *V. gamai*, i.e. at least partially equivalent to the *geslinianum* Zone (see text-fig. 3). The '*Kanabiceras* Zone' of Freund and Raab (1969) was shown to be equivalent to the standard *geslinianum* Zone by Lewy *et al.* (1984, p. 72) based on the common occurrence of the zonal index species.

Only one assemblage comprising *V. durandi* Thomas and Peron, *V. cauvini* Chudeau, *V.* cf. *cauvini*, *V. rumeaui* (Collignon), *Thomasites* cf. *subtenue* (Reyment) and *Pseudaspidoceras* sp. is from a narrow stretch within the higher part of the upper Galala Formation of section 7 (see text-fig. 2). *V. cauvini* and *V. rumeaui* are reported from the *cauvini* Zone of Israel (Freund and Raab 1969). There *V. cauvini* has also been shown to co-occur beyond with *Metoicoceras geslinianum* and *Kanabiceras* sp. ('*K.* Zone' of Freund and Raab 1969) by Lewy *et al.* (1984). According to Freund and Raab (1969), *V. durandi* (Thomas and Peron), *V. harttiforme* Choffat, *V.* cf. *amieirense* Choffat, and *V.* cf. *adonense* Choffat, which were all taken into the synonymy of *V. durandi* by Berthou *et al.* (1985), appear for the first time in the overlying *pioti* Zone; species of *Pseudaspidoceras* are reported from both *cauvini* and *pioti* Zones by Freund and Raab (1969). In Algeria, *V. cauvini*, *V. rumeaui*, and *Pseudaspidoceras* are reported from the Zone V of Amard *et al.* (1981), which is at least in part an equivalent of the *cauvini* Zone. In Portugal, *V. durandi* is known from the late Cenomanian *juddii* Zone to the early Turonian *coloradoense* Zone, having its acme in the *coloradoense* Zone (Berthou *et al.* 1985). In Tunisia, *V. durandi* '. . . appears above the correlative of the *juddii* Zone in association with fragmentary *P.* cf. *flexuosum*' (Kennedy *et al.* 1987, p. 68). Therefore, as *V. cauvini* and *V. rumeaui* co-occur in the *cauvini* Zone, the above mentioned ammonite assemblage probably comprises the *cauvini* Zone plus equivalents of the *pioti* Zone *sensu* Freund and Raab (1969).

		Portugal 1)	N' Spain 2)	Middle East 3)	Algeria 4)	Egypt present study
Early Turonian		(M)	*Wrightoceres munieri*	*Choffaticeras luciae triseliatum*	*Hoplitoides* (VI)	*Mammites sp.*
		L	*Ingridella melladee (Memmites nodosoides)*	*Choffaticeras quaasi*		*Fegesie cf. superstes*
		K?	*Paremammites saenzi*	*Choffaticeres securiforme*		
				Vascoceras ploti		*Vascoceres durandi*
Cenomanian	Late	J	*Fallotites subconcilletum*	*Vescoceras ceuvini*	*Vascoceres ceuvini, V. rumeaui* (V)	*Vascoceras cauvini, V. rumeaui*
		I				
		H				
		G			*Wrightoceras, Bauchioceras* (IV)	
		F	*Vascoceras gamei*		*Vascoceras gamai*	*Vascoceras gamai*
		E	*Metoicoceras geslinianum*	*Kanebiceras sp.*	(III)	
		D	*Metoicoceres muelleri*		*Neolobites, Pseudocalycoceras* (II)	*Metengonoceres cf. acutum*
		C	*Neolobites vibrayeanus + Calycoceras (Lotzeites) lotzei*	*Neolobites vibrayeenus*	*Neolobites vibrayeanus* (I)	*Neolobites vibreyeanus*
			Eucalycoceras spathi			

TEXT-FIG. 3. Inter-regional correlation of ammonite successions around the Cenomanian–Turonian boundary. (1) after Choffat (1898) and Berthou (1984); (2) after Wiedmann 1978; (3) after Freund and Raab (1969) and Lewy *et al.* (1984); (4) after Amard *et al.* (1981). Cenomanian–Turonian boundary and Turonian correlation after Kennedy *et al.* (1987). Late Cenomanian correlation original.

The *cauvini* Zone is apparently not well defined and its use varies in different parts of the world. In Israel it is understood to represent the uppermost Cenomanian by Lewy *et al.* (1984), who correlated it with the standard *juddii* Zone because of the common occurrence of *Pseudaspidoceras* of type *pseudonodosoides*. These authors also described *V. cauvini* from the preceding '*K.* Zone', which they correlated with the *geslinianum* Zone. However, from the drawings given by Lewy *et al.* (1984, figs. 2 and 3, table 1) it is not clear whether in their opinion the *cauvini* Zone is restricted to the Cenomanian or extends into the basal Turonian. According to Kennedy (1985, table 6) and Kennedy *et al.* (1987, p. 68), who adopted Lewy's view, the *cauvini* Zone is restricted to the late Cenomanian. In the Western Interior Basin of the US a *cauvini* Zone is distinguished between the late Cenomanian *gracile* and *juddii* Zones (Cobban 1984). Thus, although the exact relation between the southern Tethyan *cauvini* Zone and the *cauvini* and *juddii* Zones of the Western Interior Basin are in our view not yet fully understood, the authors follow the attribution of the entire *cauvini* Zone of the Middle East to the late Cenomanian as expressed by Kennedy *et al.* (1987, text-fig. 13).

Among the material collected from the weathering scree of the upper Galala Formation in section 5 (see text-fig. 1), *Fagesia* cf. *superstes* (Kossmat) and *Mammites* sp. are represented. The genera *Mammites* and *Fagesia sensu* Wright and Kennedy (1981, pp. 67, 87) are known from the early Turonian. Hook and Cobban (1981, fig. 3) reported *Fagesia* sp. together with *Neocardioceras juddii* (Barrois and de Guerne) from the Colorado Formation of New Mexico. However, Hook and Cobban (1981) did not give an illustration of the specimen from this horizon, but instead figured specimens questionably assigned to *Fagesia* (Hook and Cobban 1981, pl. 2, figs. 1–2, 5) from overlying horizons without *N. juddii*. In a later study Cobban and Hook (1983, p. 16) discussed the stratigraphical occurrence of *Fagesia* and noted: '*Fagesia* is widely distributed in rocks of early

and middle Turonian age' (latest Cenomanian = *juddii* Zone). In the Middle East, *F.* cf. *superstes* is recorded from the early Turonian *quaasi* Zone (Zone 5, see Freund and Raab 1969, p. 35). Therefore, we attribute the present specimens of *F.* cf. *superstes* and *Mammites* sp. from unspecified horizons of the upper Galala Formation to the early Turonian at a higher position than the assemblage of globose vascoceratids mentioned above.

In the present material no other undoubted early Turonian ammonites, like species of *Choffaticeras* (*sensu* Freund and Raab 1969, p. 50) which have previously been described from Egypt by Eck (1914) and Douvillé (1928), were observed, probably due to paleogeographical reasons. Thus it is impossible to propose a corresponding biozone of previous authors for the beds with *Fagesia* and *Mammites*.

Late Turonian. The marine early Turonian sediments are overlain by fluvial sandstones with an erosional contact (lower Umm Omeiyed Formation, see text-fig. 2). A new transgression is documented by the sediments of the upper Umm Omeiyed Formation, which consist of deposits of different shallow marine subfacies (Hendriks *et al.* 1987). Here *Coilopoceras requienianum* (d'Orbigny) was found in two well-defined horizons of glauconitic, calcareous sandstones in section 7, which are separated by about 8 m thick intercalations of claystones, marls, and marly limestones, containing pelecypods and echinoids (see text-fig. 2).

The type material of *C. requienianum* from the Uchaux Massif was attributed to the late Turonian *neptuni* Zone by Kennedy and Wright (1984, p. 285). The species is also recorded from the *deverianum* and *neptuni* Zones of France by Devalque *et al.* (1982) who include the *deverianum* Zone in the late Turonian. According to Kennedy (1984*a*, p. 151) the *deverianum* Zone is an equivalent of the upper part of the *woolgari* Zone, which is referred to the middle Turonian *sensu anglico*. *Collignoniceras woolgari* (Mantell) has recently been shown to co-occur successively with *Romaniceras deverianum* (d'Orbigny) and *Subprionocyclus neptuni* (Geinitz) in the eastern Paris Basin by Kennedy *et al.* (1986). The *C. requienianum* Zone of Lewy (1975) hence very likely is an equivalent of the *deverianum* and *neptuni* Zones, here regarded as late Turonian (see also Kennedy 1985, table 11).

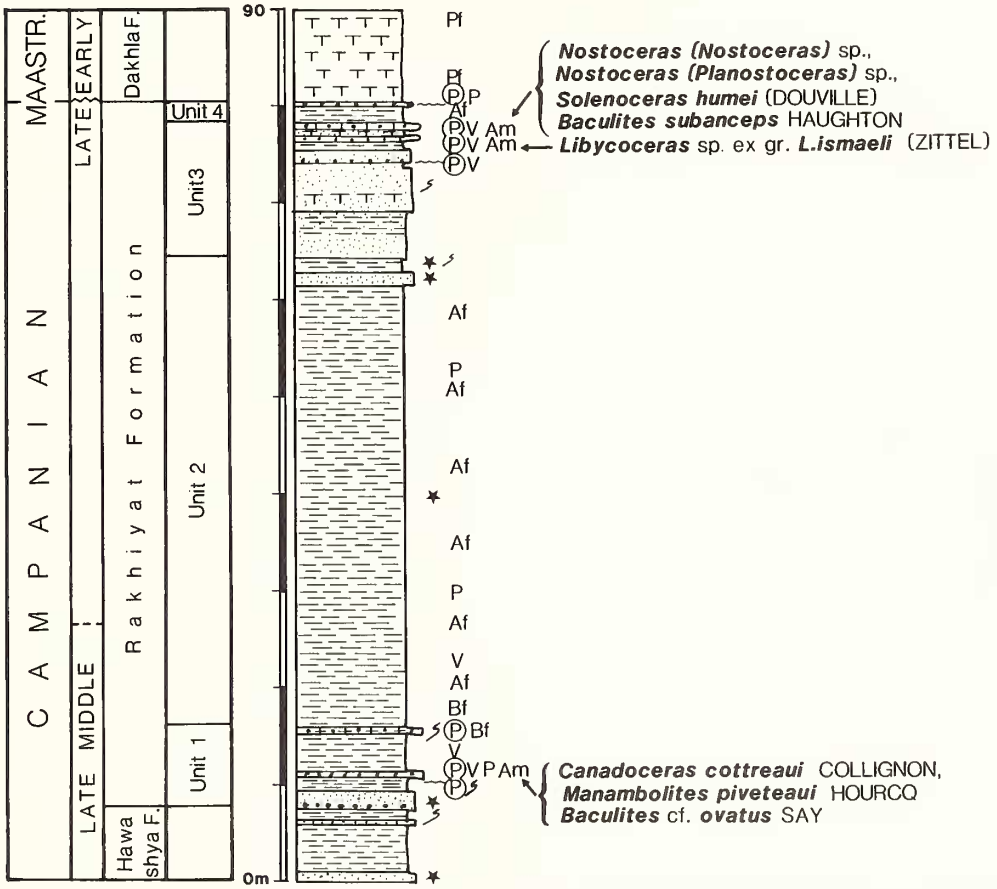
Coniacian to Maastrichtian

Coniacian–?early Campanian. The marine late Turonian is overlain by a regressive sandstone sequence (lower regressive sequence of Hawashya Formation, see text-fig. 2). The succeeding ammonite assemblage in the middle Wadi Qena consists of *Metatissotia fourneli* (Bayle), *M.* cf. *ewaldi* (von Buch), *Metatissotia* sp., and *Subtissotia africana* (Peron) from a single limestone horizon intercalated in thick massive oyster beds of the overlying lower transgressive sequence of the Hawashya Formation.

In Europe, *M. ewaldi* is known from the middle Coniacian *tridorsatum* Zone (Kennedy 1984*b*, p. 128). The species was also reported from the Ca 5 Zone of the Middle East by Lewy (1975) and Lewy and Raab (1978), together with *M. fourneli*, *M.* cf. *steinmanni* Lisson, *Tissotia* sp., *Protexanites* sp., and *Reesideoceras* sp. The CA 5 Zone in the upper Zihor Formation was tentatively assigned to the late Coniacian by Lewy and Raab (1978, p. 4), although Lewy (1975, p. 31) attributed the 'lower chalk' of the overlying Menuha Formation, barren of ammonites, to the late Coniacian *P. emscheris* Zone (= upper *tridorsatum*+*margae*+*serratomarginatus* Zones of Kennedy 1984*b*, p. 5), since the next ammonites overlying the 'lower chalk' were placed by him within the *texanus* Zone (early Santonian). This early view of Lewy was confirmed by Reiss *et al.* (1985) and Almogi-Labin *et al.* (1986, p. 852) who attributed the 'lower chalk' of the Menuha Formation to the lower part of the late Coniacian/early Santonian planktonic foraminiferal Zone of *Dicarinella concavata*. Therefore, we propose to correlate the present tissotiid assemblage with the *tridorsatum* Zone, i.e. the middle Coniacian *sensu* Kennedy (1984*b*).

In the central Wadi Qena, the marine Coniacian is overlain by a regressive sandstone sequence (upper regressive sequence of Hawashya Formation), which is succeeded by marine sediments with a poor molluscan fauna of pelecypods and gastropods (upper transgressive sequence of Hawashya

Formation, see text-fig. 2). Due to the lack of guide fossils, the age of this marine ingression remains uncertain, but it may be Santonian–?early Campanian since the base of the next datable unit (Rakhiyat Formation) is attributed to the late middle Campanian (see text-fig. 4).



TEXT-FIG. 4. Generalized section of Campanian to early Maastrichtian sediments at the Gebel Qreiya, southern end of Wadi Qena (sections 2 and 3 combined, modified after Hendriks and Luger 1987, fig. 2).

Middle Campanian–Maastrichtian. At the Gebel Qreiya at the southern end of Wadi Qena, Campanian ammonites occur in two phosphatic sequences separated by thick, almost unfossiliferous claystones (Rakhiyat Formation, see text-fig. 4). The lower assemblage consists of *Baculites* cf. *ovatus* Say, *Canadoceras cottreaui* Collignon and *Manambolites piveteaui* Hourcq. Until now, *M. piveteaui* and *C. cottreaui* were known exclusively from the 'Zone of *Delawarella subdelawarensis* and *Australiella australis*' of Madagascar, which is attributed to the 'late middle' Campanian by Collignon (e.g. Collignon 1977, table 1). Since knowledge about the stratigraphic distribution of *M. piveteaui* and *C. cottreaui* seems to be very limited and no better known ammonites (nor any other index fossils) were found co-occurring in the Gebel Qreiya section, we hesitate to

propose a correlation of the *Manambolites* layer with the European standard Zones of Kennedy (1986).

The fauna of the overlying claystones exclusively consists of rare casts of pelecypods and arenaceous foraminifera, possibly of a mixohaline facies (Hendriks and Luger 1987). Shallow open-marine conditions again are documented at this locality by the overlying intercalations of phosphoritic, calcareous, partially silicified conglomerates, and marls (upper part of unit 3 of Rakhiyat Formation, see text-fig. 4). Whereas the marls contain low-diversity calcareous foraminiferal assemblages (mainly buliminids, rare planktonics), as well as pelecypods and vertebrate remains (fish teeth), ammonites have been recovered from two of the conglomeratic horizons (Hendriks and Luger 1987). *Libycoceras* sp. ex gr. *L. ismaeli* (Zittel) was found in the lower one and an assemblage of heteromorphs (*Nostoceras* (*Nostoceras*) sp., *N.* (*Planostoceras*) sp., *Solenoceras humei* (Douvillé), *Baculites subanceps* Haughton) in the upper one, about one metre above. This upper ammonite assemblage clearly corresponds with that of Lewy (1967, 1969) from the upper Mishash Formation in Israel and that of Barthel and Herrmann-Degen (1981) from the basal Dakhla Shale Member in the Dakhla Basin. The biostratigraphic position of these assemblages falls within the late Campanian *polyplocum* Zone (Reiss *et al.* 1985).

Generally, the late Campanian deposits in the Wadi Qena and area to the south are overlain with an erosional unconformity by conglomeratic, phosphoritic marls containing besides pelecypods (*Gryphaea vesicularis* Lamarck, pectinids) and vertebrate remains a rich foraminiferal fauna of late early Maastrichtian age (upper part of the planktonic foraminiferal Zone of *Globotruncana falsostuarti*, base of Hamama Marl Member of Dakhla Formation, see Hendriks and Luger 1987). The Maastrichtian in the central and southern Wadi Qena and the Gebel Rakhiyat area is characterized by semipelagic open shelf sediments rich in planktonic and benthic foraminifera, in which no ammonites have yet been found.

SYSTEMATIC PALAEONTOLOGY

Repository of material. All specimens are stored in the collection of the Special Research Project 69 (SFB), Technical University of Berlin.

Measurement of dimensions. *D*, diameter (mm); *Wh*, *Wb*, whorl height and breadth as fractions of *D*; *Ud*, umbilical diameter as fraction of *D*.

Suture terminology. Suture terminology after Wedekind (1916) (see Kullmann and Wiedmann 1970). I, internal lobe; U, umbilical lobe; L, lateral lobe; E, external lobe.

Order AMMONOIDEA Zittel, 1884
Suborder AMMONITINA Hyatt, 1889
Superfamily DESMOCERATACEA Zittel, 1895
Family PACHYDISCIDAE Spath, 1922
Genus CANADOCERAS Spath, 1922

Type species. *Ammonites newberryanus* Meek, 1876, p. 47, by original designation of Spath (1922).

Canadoceras cottreaui Collignon, 1938

Plate 38, figs. 2 and 3

1938 *Canadoceras cottreaui* Collignon, p. 63, pl. 3, fig. 2.
1955 *Canadoceras cottreaui* Collignon; Collignon, p. 47.
1970 *Canadoceras cottreaui* Collignon; Collignon, p. 24, fig. 2301.

Material. Four fragments of body-chambers (SFB C423–C426). Each a half of a whorl. Last suture line just faintly visible on all specimens. Dimensions could not be determined.

Description. Shell moderately involute. Whorl section highly oval with flat flanks, venter rounded, shallow.

Umbilical shoulder rounded, umbilicus moderately deep. Ornamentation in general relatively faint, appearing somewhat irregular. Single ribs radiate to weakly prorsiradiate, turning to the front in the ventrolateral region, crossing the venter with a strong sweep in direction of growth. In the umbilical area, ribs are first slightly sharpened, then broaden and smoothen on the flanks, thicken slightly in the ventrolateral area and are only vaguely recognizable on the venter. Single intercalatory ribs are present, partly reaching as far as the umbilical region.

Discussion. The present material, although slightly larger, resembles the specimens described by Collignon (1938, pl. 3, fig. 2) as regards size of umbilicus and ornamentation. In his original description Collignon (1938, p. 63) mentioned the existence of four specimens of *C. cottreaui* and gave the measurements of three of them, while marking the second measured specimen as '(type)'. The measurements of his only figured specimen (Collignon 1938, pl. 3, fig. 2) are identical to those given on p. 63 for his 'no. I', and we therefore assume that the holotype of Collignon's own designation is not figured.

Occurrence. Rakhiyat Formation: Unit 1, section 2. Late middle Campanian.

C. cottreaui is recorded from the late middle Campanian ('Zone of *D. subdelawarensis* and *A. australis*') of Madagascar by Collignon (1970). The holotype of the Mitraiky section (Madagascar) was originally assigned to the late Campanian by Collignon (1938).

Superfamily HOPLITACEAE Douvillé, 1890
Family ENGONOCERATIDAE Hyatt, 1900
Genus METENGONOCERAS Hyatt, 1903

Type species. Metengonoceras inscriptum Hyatt, 1903, p. 180, pl. 25, figs. 5–9; pl. 26, figs. 1–4, by subsequent designation of Diener (1925).

Metengonoceras cf. *acutum* Hyatt, 1903

Plate 38, fig. 1; text-fig. 6D

cf. 1903 *Metengonoceras acutum* Hyatt, p. 184, pl. 26, fig. 8; pl. 27, figs. 1 and 2.
cf. 1981 *Metengonoceras acutum* Hyatt; Kennedy *et al.*, text-fig. 5A.
cf. 1987 *Metengonoceras acutum* Hyatt; Cobban, p. 63, pl. 1, figs. 1 and 2, 7; pl. 2, figs. 4–8; pl. 3 (see here for complete synonymy).

Material. Nine poorly preserved fragments (SFB C279–C287). One of them with partially preserved body-chamber. Dimensions could not be determined.

Discussion. The present fragments of internal moulds, which apart from very faint, short fold-like ribs near the umbilicus lack any trace of ornamentation, very closely resemble *M. acutum* in their straight suture trace (text-fig. 6D) and the sharpened venter on body-chamber. However, due to the poor preservation the present specimens cannot be assigned unequivocally to *M. acutum*. *M. acutum* differs from the similar species *M. dumbli* (Cragin, 1893) in the sharpened instead of rounded venter on the body-chamber (Cobban 1987) and the straight instead of curved suture line (Kennedy *et al.* 1981).

Occurrence. Galala Formation: Locality A (SFB C279). Middle Galala Formation: Section 5 (SFB C281–C287) and section 7 (SFB C280). Late Cenomanian.

The holotype of *M. acutum* was assigned to the later Cenomanian (*gracile* Zone) by Kennedy *et al.* (1981). The species is known from the late Cenomanian *pondi* to *gracile* Zones of the Western Interior of the United States (Cobban 1987).

Genus NEOLOBITES Fischer, 1882

Type species. Ammonites vibrayeanus d'Orbigny, 1841, p. 322, pl. 96, figs. 1–3, by original designation of Fischer (1882).

TEXT-FIG. 5. *Neolobites vibrayeanus* (d'Orbigny). SFB C265, section 7, lower *Neolobites* assemblage, lower Galala Formation, early late Cenomanian, × 1.

EXPLANATION OF PLATE 38

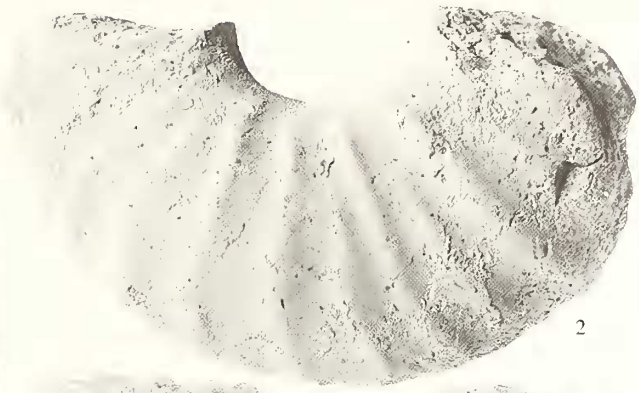
Fig. 1. *Metengonoceras* cf. *acutum* Hyatt. SFB C279, fragmentary phragmocone, loeality A, Galala Formation, late Cenomanian.

Figs. 2 and 3. *Canadoceras cottreaui* Collignon. 2, SFB C424; 3, SFB C423. Fragmentary body-chambers, both from section 2, basal phosphate horizon of Rakhiyat Formation, late middle Campanian.

Figs. 4–6. *Neolobites* sp. 4, SFB C252; 5 and 6, SFB C253. Both speeimens from seetion 7, lower Galala Formation, lower *Neolobites*-assemblage, late Cenomanian.

All figures × 1.


1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LUGER and GRÖSCHKE, *Metengonoceras*, *Canadoceras*, *Neolobites*

Neolobites vibrayeanus (d'Orbigny, 1841)

Plate 39, fig. 3; text-fig. 5

1841 *Ammonites vibrayeanus* d'Orbigny, p. 322, pl. 96, figs. 1–3.
1981 *Neolobites vibrayeanus* (d'Orbigny); Kennedy and Juignet, p. 23, figs. 3*a–c*, 4*a*, *b*, 5, 6*a* (see here for further synonymy and refigured holotype).
1985 *Neolobites* cf. *vibrayeanus* (d'Orbigny); Dominik, pl. 14, figs. 4 and 8.

Material. Six internal moulds (SFB C265–C270). The shell is partially preserved in one specimen. The body-chamber, up to half a whorl, is partially preserved in three specimens, the largest of which shows a diameter of 146 mm.

Description. The extremely involute, highly compressed specimens, in which the umbilicus reaches only up to 5% of the diameter, show weak rib-like folds on the inner flanks, which arise from the umbilicus. No ornamentation is visible on the outer flanks, possibly due to the poor preservation. In the smallest specimen (SFB C270) the lateral surface is smooth at a whorl height of 22 mm, later on ribs arise and strengthen to the outer whorl. The venter is narrow and flat in the outer, subsulcate in the inner whorls.

Discussion. The present specimens very closely resemble the holotype as refigured by Kennedy and Juignet (1981, fig. 3*a–c*); however, their ornamentation is slightly weaker and the umbilicus a little narrower.

Occurrence. Lower Galala Formation: Lower (SFB C265) and upper (SFB C266–C270) *Neolobites*-assemblage, section 7. Late Cenomanian.

According to Kennedy and Juignet (1981), *N. vibrayeanus* is known from the earlier late Cenomanian of western Europe (France, Spain, Portugal), northern Africa and the Middle East (Morocco, Algeria, Tunisia, Egypt, Israel, Lebanon, Arabia), as well as South America (Peru, Bolivia).

Neolobites sp.

Plate 38, figs. 4–6; text-fig. 13D, E

Material. Thirteen specimens (C252–C264). Mainly internal moulds of phragmocones, with partial remains of shell; body-chamber of about half a whorl preserved in two specimens.

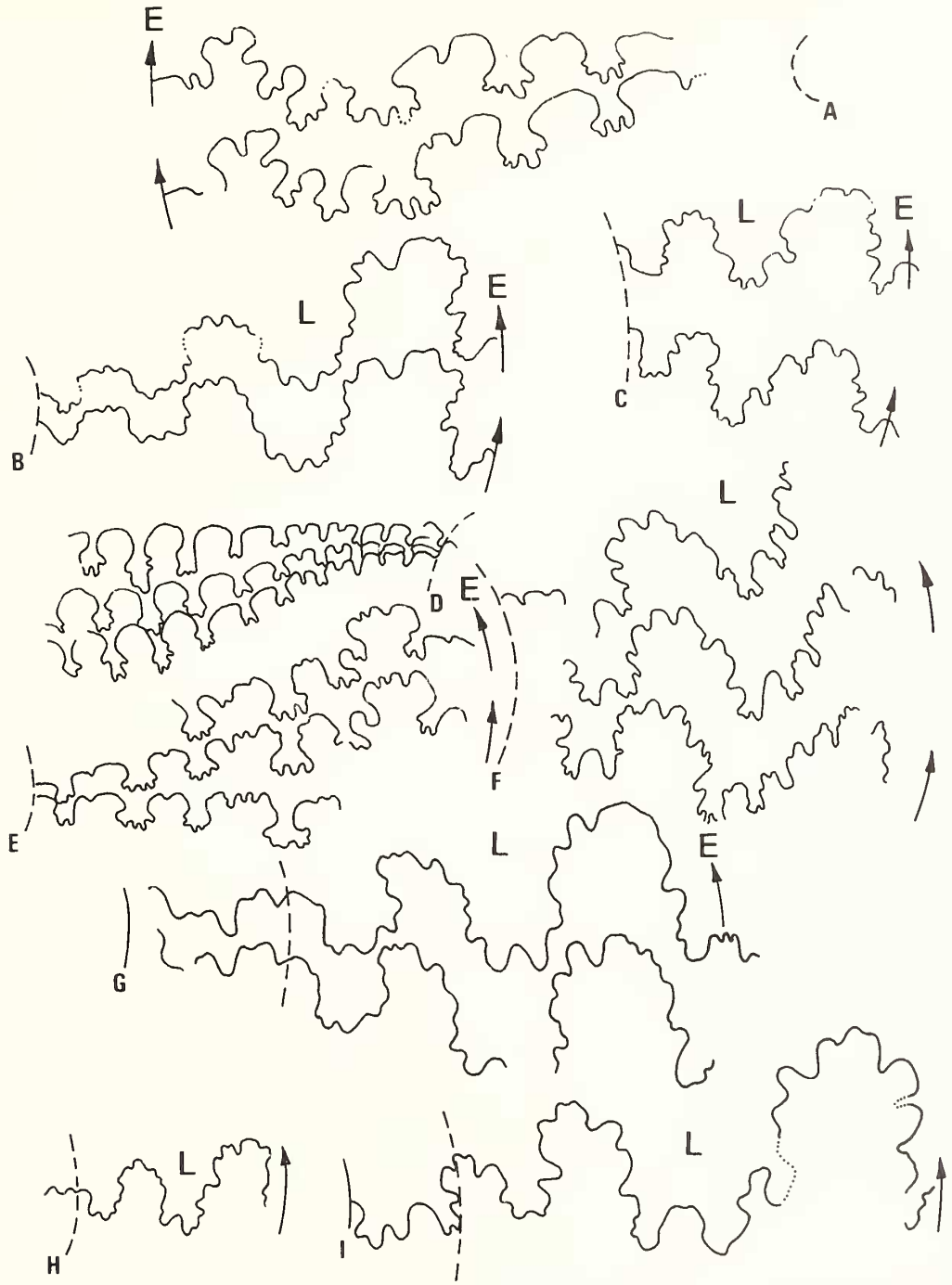
Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C253	38	0·56	0·31	0·12
SFB C264	86	0·52	0·23	0·12
SFB C252	115	0·59	0·25	0·12

Description. Shell compressed with high whorl sides and small umbilicus; coiling becomes excentric on body-chamber. Venter subsulcate to flat, becoming rounded on body-chamber. Cross-section shown in text-fig. 13D, E. Ornamentation of phragmocone consists of almost straight ribs on the inner flanks arising from the umbilicus at early growth stages. Ribs are broadening and weakening on the outer flanks. Elongated ventrolateral tubercles are developed on the phragmocone. On body-chamber ornamentation only consists of broad folds on the inner flanks.

Discussion. Neolobites sp. differs from *N. vibrayeanus* (d'Orbigny, 1841) as figured by Kennedy and Juignet (1981, fig. 3A–C, holotype) and the present specimens by its larger umbilicus, its excentric coiling of the body-chamber, the elongated ventrolateral tubercles on the phragmocone, and the rounded venter of the body-chamber. *Neolobites* sp. is, as regards mode of coiling and ribbing, very close to the holotype of *N. choffati* Hyatt, 1903 (pl. 25, figs. 1–4 = *N. vibrayeanus* (d'Orbigny) in Choffat 1898, pl. 5, figs. 3, 8–9). However, neither from Hyatt's nor Choffat's descriptions and illustrations can it be recognized whether *N. choffati* (*sensu* Hyatt 1903) bears ventrolateral tubercles or not. *Neolobites* sp. is also very similar to *N. peroni* Hyatt, 1903, a form with ventrolateral tubercles which, according to Collignon (1965), shows a narrower umbilicus.

The present specimens of *Neolobites* are from two well-defined horizons; the thirteen specimens here referred to as *Neolobites* sp. are exclusively from the lower unit and show hardly any variation



TEXT-FIG. 6. External sutures of: A, E, *Coilopoceras requienianum* (d'Orbigny). A, SFB C329; E, SFB C331. Both ×2. B, *Thomasites compressus* (Barber). SFB C315, ×2. C, *Vascoceras gamai* Choffat. SFB C309, ×3. D, *Metengonoceras* cf. *acutum* Hyatt. SFB C279, ×2. F, *V.* cf. *cauvini* Chudeau. SFB C306, ×2. G, H, *V. cauvini* Chudeau. G, SFB C295, ×2; H, SFB C296, ×1. I, *Pseudaspidoceras* sp. SFB C316, ×2.

as regards size of umbilicus and ornamentation. Only one specimen of *N. vibrayeanus* was found together with them. All the specimens of *Neolobites* from the upper horizon show the flat, non-tuberculate venter up to large growth stages of true *N. vibrayeanus* (see Kennedy and Juignet 1981, fig. 3*a–c*, holotype). The differences between the present *N. vibrayeanus* and *Neolobites* sp. could be related to dimorphism as they co-occur in the lower horizon; this seems, however, unlikely since *Neolobites* sp. was not observed in the upper one.

N. choffati and *N. peroni* have been considered to be junior synonyms of *N. vibrayeanus* by Kennedy and Juignet (1981) without a detailed discussion. Collignon (1965, p. 169) discussed the species of *N. vibrayeanus*, *N. peroni*, and *N. fourtaui* Pervinquière, 1907, but the detailed stratigraphic relationships of the figured specimens remained uncertain. This is also the case for Avnimelech and Shoresh (1962, p. 530) who doubted the validity of *N. peroni* and *N. choffati*. However, from the present material it cannot be decided whether the high variability attributed to *N. vibrayeanus* by Kennedy and Juignet (1981) is in accordance with reality or hides biostratigraphical or other parameters which could justify a separation of distinct species.

Occurrence. Lower Galala Formation: Lower *Neolobites*-assemblage, section 5 (SFB C263–C264) and section 7 (SFB C252–C262). Late Cenomanian.

Superfamily ACANTHOCERATACEAE de Grossouvre, 1894
Family ACANTHOCERATIDAE de Grossouvre, 1894
Subfamily ACANTHOCERATINAE de Grossouvre, 1894
Genus PSEUDOCALYCOCERAS Thomel, 1969

Type species. Ammonites harpax Stoliczka, 1864, p. 72 (*pars*), pl. 39, fig. 1 only, by original designation of Thomel (1969).

Pseudocalycoceras cf. *haugi* (Pervinquière, 1907)

Plate 39, figs. 1 and 2

cf. 1907 *Acanthoceras haugi* Pervinquière, p. 270, pl. 14, fig. 1*a*, *b*.
cf. 1972 *Pseudocalycoceras* (*Haugiceras*) *haugi* (Pervinquière); Thomel, p. 97, pl. 31, figs. 7 and 8.

Material. Four poorly preserved fragmentary internal moulds (SFB C275–C278). Dimensions could not be determined.

Description. Shell moderately evolute. Umbilical shoulder rounded. Whorl section subsquarish, a little broader than high. Venter flat. Ornamentation coarse; one umbilical and two ventrolateral rows of nodes developed, which are connected by radial primary ribs. Lateral intercalatory ribs present, also bearing ventrolateral nodes. In the outer ventrolateral row nodes are claviform. Whorls do not embrace the inner ventrolateral row of nodes. Suture line not visible.

Discussion. The present specimens are strongly eroded, especially in the ventral regions. However, the mode of coiling and the ornamentation is very similar to that of *P. haugi*, but due to the poor preservation our specimens are only compared with this species. The specimen figured by Thomel (1972, pl. 31, figs. 7 and 8) from the late Cenomanian of France shows a smaller umbilicus than our material and the holotype (Pervinquière 1907, pl. 14, fig. 1*a*, *b*).

EXPLANATION OF PLATE 39

Figs. 1 and 2. *Pseudocalycoceras* cf. *haugi* (Pervinquière). 1, SFB C276; 2, SFB C275. Both specimens from section 7, lower Galala Formation, upper *Neolobites*-assemblage, early late Cenomanian.

Fig. 3. *Neolobites vibrayeanus* d'Orbigny. SFB C266, section 7, lower Galala Formation, upper *Neolobites*-assemblage, early late Cenomanian.

All figures × 1.

LUGER and GRÖSCHKE, *Pseudocalycoceras*, *Neolobites*

P. haugi, originally attributed to *Acanthoceras*, was assigned to *Pseudocalycoceras* by Thomel (1972) and chosen as subgenotype of *Haugiceras* Thomel, 1972. Wright and Kennedy (1981, p. 36) discussed the genus *Pseudocalycoceras* and rejected the subgenus *Haugiceras* by noting: 'The type species as figured by Pervinquière is, however, so similar to typical *Pseudocalycoceras* that separation is in our opinion unnecessary.'

P. haugi was also reported, but not figured, by Avnimelech and Shoresh (1962, p. 532) as '*Calycoceras*' *haugi* from the Cenomanian of Israel, prior to the occurrence of *Neolobites* ('Calcaire à *Acanthoceras*'). These authors, apparently tentatively, regarded '*A.*' *palestinense* Blanckenhorn, 1905 as figured by Taubenhaus (1920, pl. 2, fig. 3) as synonymous with *P. haugi* (a view which was adopted by Thomel 1972). The specimen figured by Taubenhaus (1920) is, however, much more densely ribbed and the ribs are finer than in Pervinquière's holotype, so that we suggest keeping the two forms separate. Since Avnimelech and Shoresh (1962) did not give an illustration of their '*C.*' *haugi*, this report remains questionable.

Occurrence. Lower Galala Formation: Upper *Neolobites*-assemblage, section 7. Late Cenomanian.

P. haugi is known from the Cenomanian of Tunisia and the late Cenomanian of France (Thomel 1972).

Subfamily MAMMITINAE Hyatt, 1900

Genus MAMMITES Laube and Bruder, 1887

Type species. Ammonites nodosoides Schlüter, 1871, p. 19, pl. 8, figs. 1–4, by monotypy (see Wright and Kennedy 1981, p. 75).

Mammites spp.

Plate 40, fig. 4

Material. Three fragments (SFB C326–C328). Dimensions could not be determined.

Discussion. Three poorly preserved, variably large fragments of internal moulds of body-chambers of the genus *Mammites* are present in the investigated material. Apparently these represent two different species. In the first form (Pl. 40, fig. 4), represented by two different-sized but large body-chambers, the whorl section is rectangular, little wider than high and the venter is flat. In the other one the cross-section is higher than wide and the venter is rounded (not figured). Both forms show the typical ornamentation with large, obliquely projecting ventrolateral nodes, which are connected with smaller, elongated umbilical bulges by broad, ill-defined ribs. The venter apparently is smooth. Suture line only faintly visible in one specimen.

Due to the poor preservation the present specimens cannot be determined at the specific level.

Occurrence. Upper Galala Formation: Section 5. Early Turonian.

Genus PSEUDASPIDOCERAS Hyatt, 1903

Type species. Ammonites footeanus Stoliczka, 1864, p. 101, pl. 52, figs. 1, 1*a–c* and 2, 2*a*, by original designation of Hyatt (1903).

EXPLANATION OF PLATE 40

Figs. 1 and 2. *Fagesia* cf. *superstes* (Kossmat). SFB C323, section 5, upper Galala Formation, early Turonian.

Figs. 3, 6, 8–9. *Vascoceras cauvini* Chudeau. SFB C480. 3 and 6, outer whorl and 8 and 9, inner whorl of the same specimen, section 5, upper Galala Formation, late Cenomanian.

Fig. 4. *Mammites* sp. SFB C326, section 5, upper Galala Formation, early Turonian.

Figs. 5 and 7. *V. gamai* Choffat. 5, SFB C309; 7, SFB C310. Both specimens from section 5, upper Galala Formation, late Cenomanian.

All figures ×1.

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LUGER and GRÖSCHKE, *Fagesia*, *Vascoceras*, *Mammites*

Pseudaspidoceras sp.

Text-fig. 61

Material. Six fragments of internal moulds (SFB C316–C321). Five of phragmocones and one body-chamber of half a whorl. Dimensions could not be determined.

Description. Shell very evolute. Whorl section subsquarish with a slightly convex venter in the smaller and a flat venter in the larger specimens. Large umbilicus with angularly rounded shoulders and steep vertical walls. Ornamentation consists of elongated ventrolateral nodes and smaller umbilical tubercles. Space in between them sometimes covered by shallow elevations. Outer ventrolateral nodes not clearly observed due to the poor preservation. Suture line shown in text-fig. 61.

Discussion. The present specimens cannot safely be determined at the specific level because of their poor preservation. However, they are similar to *P.* cf. *P. pseudonodosoides* (Choffat, 1898) in Freund and Raab (1969, pl. 1, figs. 10 and 11) from the *cauvini* Zone of the Negev.

Occurrence. Upper Galala Formation: Section 7. Latest Cenomanian.

Family VASCOCERATIDAE Douvillé, 1912
Subfamily VASCOCERATINAE Douvillé, 1912
Genus FAGESIA Pervinquière, 1907

Type species. Olcostephanus superstes Kossmat, 1897, p. 26 (133), pl. 6 (17), fig. 1*a–c*, by original designation of Pervinquière (1907).

Fagesia cf. *superstes* (Kossmat, 1897)

Plate 40, figs. 1 and 2

cf. 1897 *Olcostephanus superstes* Kossmat, p. 26 (133), pl. 6 (17), fig. 1*a–c*.
cf. 1907 *Fagesia superstes* Kossmat; Pervinquière, p. 322, pl. 20, figs. 1–4A; fig. 122.
cf. 1969 *Fagesia* cf. *F. superstes* (Kossmat); Freund and Raab, p. 35, text-fig. 7*f*.
cf. 1983 *Fagesia superstes* (Kossmat); Cobban and Hook, p. 16, pl. 3, figs. 1–2; pl. 13, figs. 6–11; fig. 12 (see here for complete synonymy).

Material. Three fragments of internal moulds (SFB C323–C325) comprising two phragmocones and one body-chamber, each about half a whorl. Dimensions could not be determined.

Description. Shell evolute, cadicone. Moderately large umbilicus with angularly rounded shoulders and high vertical walls. Whorl section broadly rounded, very low, more than twice as wide as high. Ornamentation consists of large umbilical tubercles, each giving rise to two diverging, coarse ribs which cross the venter uninterruptedly. Suture line hardly visible.

Discussion. The present specimens very closely resemble *F. superstes* as figured by Kossmat (1897, pl. 6, fig. 1) and Pervinquière (1907, pl. 20, figs. 1–4). However, in the present material the ribs are coarser and more widely spaced than in typical *F. superstes*.

Occurrence. Upper Galala Formation: Section 5. Early Turonian.

The species is known from the early Turonian of India, North Africa, and the Middle East (Freund and Raab 1969) as well as Mexico (Cobban and Hook 1983).

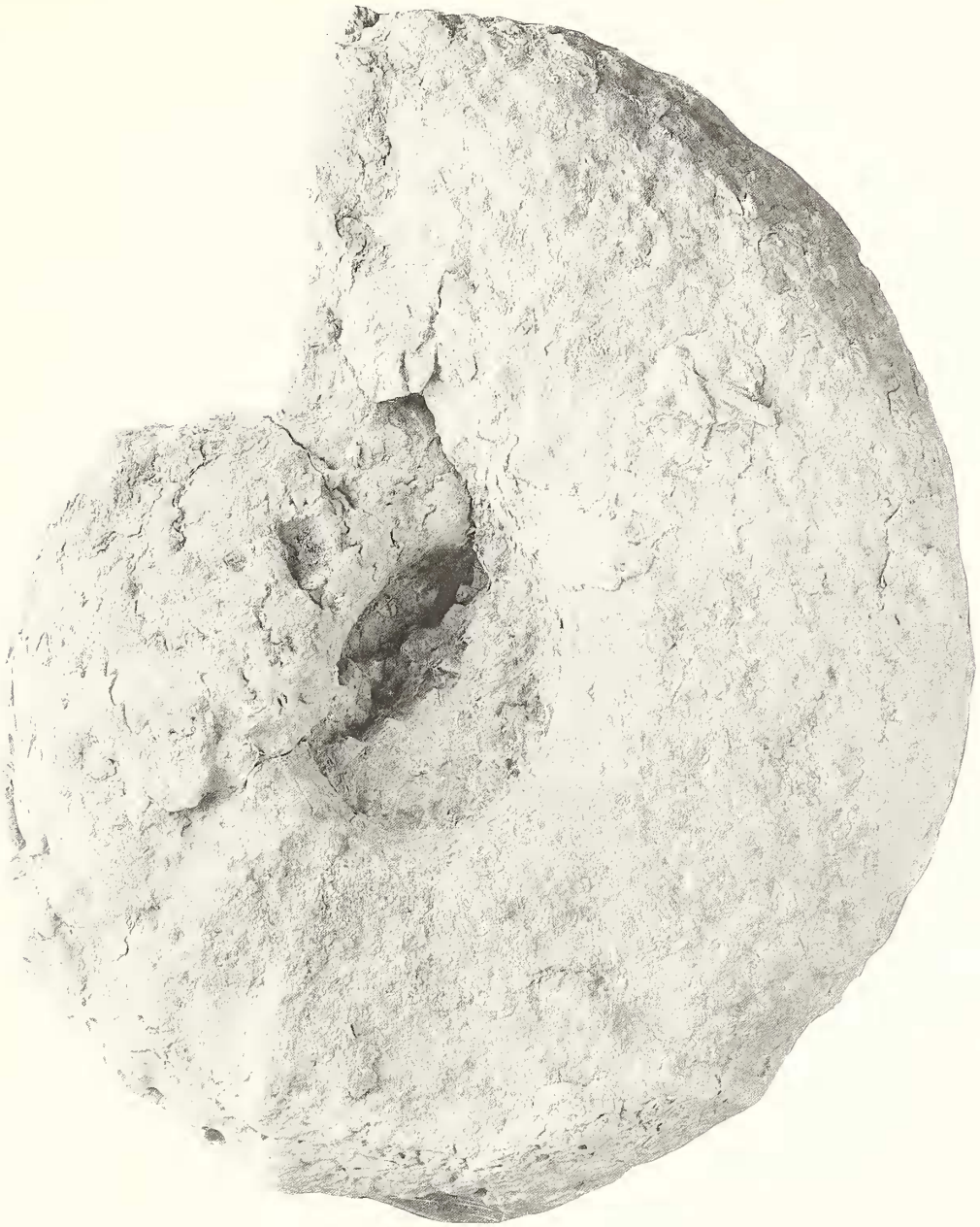
Genus NIGERICERAS Schneegans, 1943

Type species. Nigericeras gignouxi Schneegans, 1943, p. 119, pl. 5, figs. 10–15, by subsequent designation of Reyment (1955).

Nigericeras? *timrhertense* Collignon and Roman, 1981

Text-fig. 7

1981 *Nigericeras timrhertense* Collignon and Roman *in* Amard *et al.*, p. 55, pl. 8, fig. 2.



TEXT-FIG. 7. *Nigericeras tinrhertense* Collignon and Roman. SFB C312, section 5, upper Galala Formation, late Cenomanian or earliest Turonian, × 1.

Material. One internal mould (SFB C312). Body-chamber preserved up to three-quarters of last whorl, phragmocone slightly distorted. Dimensions could not be determined.

Description. Shell evolute, faintly compressed. Medium-sized umbilicus with rounded shoulders and vertical walls. Whorl section almost subsquarish, only faintly higher than wide. Venter rounded. Phragmocone and

inner part of body-chamber ornamented by widely spaced coarse ribs crossing the venter, which are almost straight on the inner and prorsiradiate on the outer flanks. Outer part of body-chamber smooth, as far as can be observed. Suture line poorly preserved.

Discussion. Although slightly less depressed and larger the present specimen very closely resembles *N. tinrhertense* (see Amard *et al.* 1981). The inner whorls of this species, which was based on a single specimen, are unknown. Since the present specimen also does not permit further observation the generic assignment to *Nigericeras* remains questionable.

Occurrence. Upper Galala Formation: Section 5. Latest Cenomanian or earliest Turonian.

N. tinrhertense was originally described from Zone V of the Tinrhert, Algeria, which was assigned to the early Turonian by Amard *et al.* (1981). The fauna of Zone V of these authors very closely resembles that of the *cauvini* Zone of Freund and Raab (1969), which is now included in the late Cenomanian by Kennedy *et al.* (1987).

Genus VASCOCERAS Choffat, 1898

Type species. Vascoceras gamai Choffat, 1898, p. 54, pl. 7, figs. 1–4; pl. 8, fig. 1; pl. 10, fig. 2; pl. 21, figs. 1–5, by subsequent designation of Roman (1938).

Remarks. Kennedy *et al.* (1987) emended the definition of *Vascoceras* and included *Paravascoceras* Furon, 1935, *Pachyvascoceras* Furon, 1935, *Paracanthoceras* Furon, 1935, *Broggiiceras* Benavides-Cáceres, 1956, *Discovascoceras* Collignon, 1957, and *Provascoceras* Cooper, 1979 as synonyms. This view is followed herein.

Vascoceras cauvini Chudeau, 1909

Plate 40, figs. 3, 6, 8–9; Plate 41, figs. 1–4; Plate 42, fig. 1; text-figs. 6G, H and 8C.

1909 *Vascoceras cauvini* Chudeau, p. 67, pl. 1, figs. 1*a* and 2*a*; pl. 2, figs. 3 and 5; pl. 3, figs. 1*b*, 2*b*, 4.
?1915 *Acanthoceras mantelli*(?) Sowerby; Greco, p. 207, pl. 18, figs. 1 and 2.
?1915 *Vascoceras durandi* Thomas and Peron; Greco, p. 268, pl. 9, fig. 9.
1921 *Thomasites cauvini* (Chudeau); Chudeau, p. 463, fig. 1.
1933 *Vascoceras cauvini* Chudeau; Furon, p. 268, pl. 9, fig. 17.
1935 *Vascoceras* (*Paravascoceras*) *cauvini* Chudeau; Furon, p. 60, pl. 5, fig. 1.
1943 *Paravascoceras cauvini* (Chudeau); Schneegans, p. 128, pl. 4, fig. 2; fig. 9*a–f*.
1956 *Broggiiceras humboldti* Benavides-Cáceres, p. 470, pl. 56, figs. 3–6.
?1957 *Paravascoceras* aff. *cauvini* (Chudeau); Barber, p. 37, pl. 14, figs. 2 and 3; pl. 32, figs. 8 and 9.
1969 *Paravascoceras cauvini* (Chudeau); Freund and Raab, p. 20, pl. 3, figs. 1–3; text-fig. 5*a–b*.
1975 *Paravascoceras cauvini* (Chudeau); Schöbel, p. 119, pl. 4, figs. 1–3; pl. 5, figs. 1–4.
?1978 *Vascoceras* (*Paravascoceras*) cf. *cauvini* Chudeau; Cooper, p. 130, text-figs. 6*c–h*, 35–37.
1981 *Paravascoceras cauvini* (Chudeau); Amard *et al.*, p. 51, pl. 3, fig. 9.

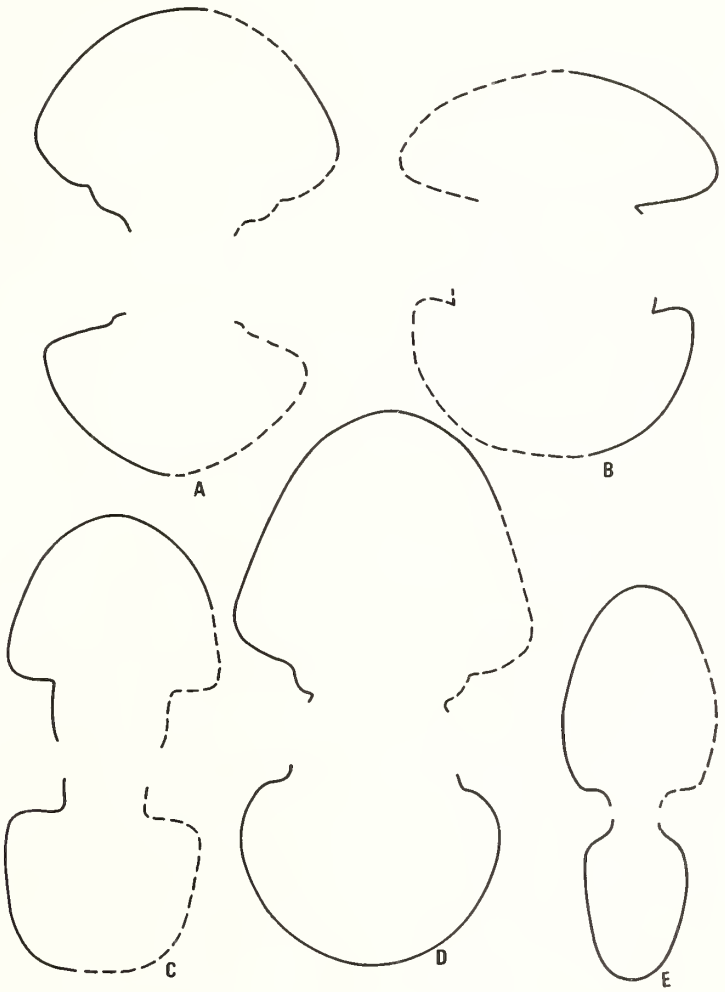
Material. Twelve specimens (SFB C294–C304, C480). All are internal moulds, four of them with partially preserved body-chambers of up to three-quarters of a whorl.

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C294	91	0·39	0·42	0·28
SFB C295	88	0·43	—	0·26
SFB C296	89	0·41	—	0·24
SFB C297	100	0·43	—	0·27

Description. The whorl section (text-fig. 8C) varies from faintly depressed to compressed with slightly inclined flanks. Venter well rounded. Umbilicus moderately wide with rounded shoulders and vertical to oblique walls. Most specimens without ornamentation, as far as preservation permits observation. Only one specimen shows faint, weak marginal ribs crossing the venter. Suture line poorly preserved in three specimens (see text-fig. 6G–H).

Discussion. The present specimens closely resemble *V. cauvini* Chudeau, 1909 (pls. 1–3) in size, shape, and suture line. They differ from Chudeau's type material in their very weak to absent ornamentation. According to Schöbel (1975), *V. cauvini* displays variation in the degree of compression and ornamentation. Therefore, the present specimens mostly represent the unornamented variety in the sense of Schöbel (1975). The latter author suggested in his study *V. rumeaui* Collignon, 1957 to be a synonym of *V. cauvini*. In the present material these two forms can clearly be separated since *V. rumeaui* shows a considerably broader cross-section and a narrower umbilicus. According to Berthou *et al.* (1985, p. 72), *V. cauvini* is possibly a junior synonym of *V. barcoicense* Choffat, 1898.



TEXT-FIG. 8. Whorl sections of: A, *Vascoceras durandi* Thomas and Peron. SFB C292. B, *V.* cf. *cauvini* Chudeau. SFB C305. C, *V. cauvini* Chudeau. SFB C294. D, *V. rumeaui* (Collignon). SFB C288. E, *Thomasites compressus* (Barber). SFB C314. All ×0·67.

Occurrence. Upper Galala Formation: Section 5 (SFB C294–C302, C480), section 6 (SFB C304), and section 7 (SFB C303). Late Cenomanian.

V. cauvini is widely known from central and northern Africa, the Middle East, and Peru. The *cauvini* Zone of Freund and Raab (1969), originally assigned to the early Turonian, is now placed in the late Cenomanian by Kennedy *et al.* (1987).

Vascoceras cf. *cauvini* Chudeau, 1909

Plate 42, fig. 2; Plate 43, fig. 3; text-figs. 6F and 8B

Material. Two internal moulds of phragmocones (SFB C305, C306), one with body-chamber preserved of up to half a whorl.

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C305	79	0·37	—	0·27
SFB C306	98	0·50	—	0·21

Description. Shell moderately evolute. Whorl section strongly depressed on phragmocone, less depressed on body-chamber. Moderately large umbilicus with rounded shoulder and high vertical walls. Flanks and venter well rounded (text-fig. 8B). No ornamentation observed. Initial whorls unknown. Suture line with characteristic broad V-shaped lateral lobe (text-fig. 6F).

Discussion. In the investigated material *V.* cf. *cauvini* differs from the specimens attributed to *V. cauvini* and the type material as figured by Chudeau (1909) in its more depressed whorl section at comparable growth stages. The suture line of *V.* cf. *cauvini* falls within the range of variation attributed to *V. cauvini* by Chudeau (1921, fig. 1), Schneegans (1943, figs. 9*a–f* and 11), and Freund and Raab (1969, fig. 5*a*). Schöbel (1975) attributed a high variability of the whorl section to *V. cauvini*, varying from compressed to depressed. According to Berthou *et al.* (1985, pp. 72, 75), *V. cauvini* is more compressed than *V. durandi* (Thomas and Peron, 1890). Therefore, as the whorl section of the specimens here referred to as *V.* cf. *cauvini* is as much depressed as in the more evolute species *V. durandi*, we hesitate to attribute these extremely depressed morphotypes (e.g. specimen SFB C305) to the generally rather compressed species *V. cauvini*.

Occurrence. Upper Galala Formation: Section 7. Latest Cenomanian.

Vascoceras durandi (Thomas and Peron, 1890)

Plate 43, figs. 1 and 2; text-fig. 8A

1890 *Pachydiscus durandi* Thomas and Peron; Peron, p. 27, pl. 18, figs. 5–8.
1898 *Vascoceras amieirensis* Choffat, p. 61, pl. 12, figs. 1 and 2; pl. 13, figs. 1 and 2; pl. 21, figs. 17–21.
1928 *Vascoceras* sp.; Douvillé, p. 15, pl. 1, fig. 6.
?1957 *Discovascoceras* cf. *amieirense* Choffat; Collignon, p. 124.
1969 *Vascoceras* cf. *V. amieirense* Choffat; Freund and Raab, p. 32, text-fig. 6*k*, *l*.
1985 *Vascoceras durandi* (Peron); Berthou *et al.*, p. 72, pl. 4, figs. 4–9; pl. 6, figs. 1–6 (see here for complete synonymy).

Material. Two internal moulds of phragmocones (SFB C292–C293).

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C292	102	0·40	—	0·30
SFB C293	69	0·35	—	0·32

Description. Shell moderately evolute, strongly depressed. Wide umbilicus with angularly rounded shoulders and steep vertical walls. Whorl section rounded (text-fig. 8A), at first much wider than high, later becoming

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EXPLANATION OF PLATE 41

Figs. 1–4. *Vascoceras cauvini* Chudeau. 1 and 2, SFB C302, fragmentary body-chamber; 3 and 4, SFB C298. Both specimens from Section 5, upper Galala Formation, late Cenomanian.
Figs. 5 and 6. *V. rumeaui* (Collignon). SFB C288, section 7, upper Galala Formation, late Cenomanian.
All figures × 1.

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LUGER and GRÖSCHKE, *Vascoceras*

less depressed. No ornamentation observed even at growth stages of 40 mm diameter (smaller specimen). Suture line only rudimentarily preserved with a large first lateral saddle and two successively smaller accessory saddles, the inner one being situated immediately at the umbilical shoulder.

Discussion. The present specimens are very close to *V. amieirensis* Choffat, 1898 (p. 61, pl. 12, fig. 1*a–b*) as well as to the specimen figured as *Vascoceras* sp. by Douvillé (1928, pl. 1, fig. 6).

In a revision of the Portuguese species of *Vascoceras*, Berthou *et al.* (1985, p. 72) regarded the species *V. douvillei* Choffat, 1898 and *V. amieirensis* as junior synonyms of *V. durandi*. The authors interpreted the presence or absence of umbilical tubercles in the earlier growth stages of *V. durandi* as being related to geographical variation. Therefore, as far as can be observed, the present specimens may represent a smooth variety of *V. durandi*.

V. durandi is very similar to *V. cauvini* Chudeau, 1909, from which it differs in its larger umbilicus and more depressed whorl section at comparable growth stages. For detailed discussion of *V. durandi* see Berthou *et al.* (1985, p. 72).

Occurrence. Upper Galala Formation: Section 6 (SFB C293) and section 7 (SFB C292).

The species is known from the late Cenomanian to early Turonian of Choffat's beds 'G' to 'L' in Portugal (Berthou *et al.* 1985). In Israel it is reported only from the early Turonian *pioti* and *quaasi* Zones (Freund and Raab 1969). *V. durandi* is also known from Spain, Algeria, Tunisia, Japan and questionably Angola, Mexico, and Brasil (Berthou *et al.* 1985).

Vascoceras gamai Choffat, 1898

Plate 40, figs. 5 and 7; text-fig. 6c

1898 *Vascoceras gamai* Choffat, p. 54, pl. 7, figs. 1–4; pl. 8, fig. 1; pl. 10, fig. 2; pl. 21, figs. 1–4.
1898 *Vascoceras gamai* var. *subtriangularis* Choffat, p. 55, pl. 7, fig. 5; pl. 21, fig. 5.
1898 *Vascoceras adonensis* Choffat, p. 59, pl. 9, fig. 3; pl. 21, fig. 12.
1898 *Vascoceras mundae* Choffat, p. 56, pl. 8, figs. 2–4; pl. 10, fig. 1; pl. 21, figs. 6–8, 10.
1898 *Ammonites* (*Vascoceras?*) *grossouvrei* Choffat, p. 68, pl. 9, figs. 1 and 2; pl. 22, figs. 37 and 38.
1898 *Vascoceras* cf. *barcoisensis* Choffat, pl. 16, fig. 11; pl. 22, fig. 36 (*non Vascoceras barcoisensis* Choffat, p. 67, pl. 17, fig. 1; pl. 22, fig. 35).
1928 *Vascoceras gamai* Choffat; Douvillé, p. 13, fig. 3; pl. 1, fig. 4.
1975 *Vascoceras gamai* Choffat; Berthou *et al.*, p. 81.
1981 *Vascoceras gamai* Choffat; Wright and Kennedy, p. 86.
?1981 *Vascoceras gamai* Choffat; Amard *et al.*, p. 102.
1985 *Vascoceras gamai* Choffat; Berthou *et al.*, p. 66, pl. 2, figs. 1–12; pl. 3, figs. 1–3, 5–7, 10, 13–14.

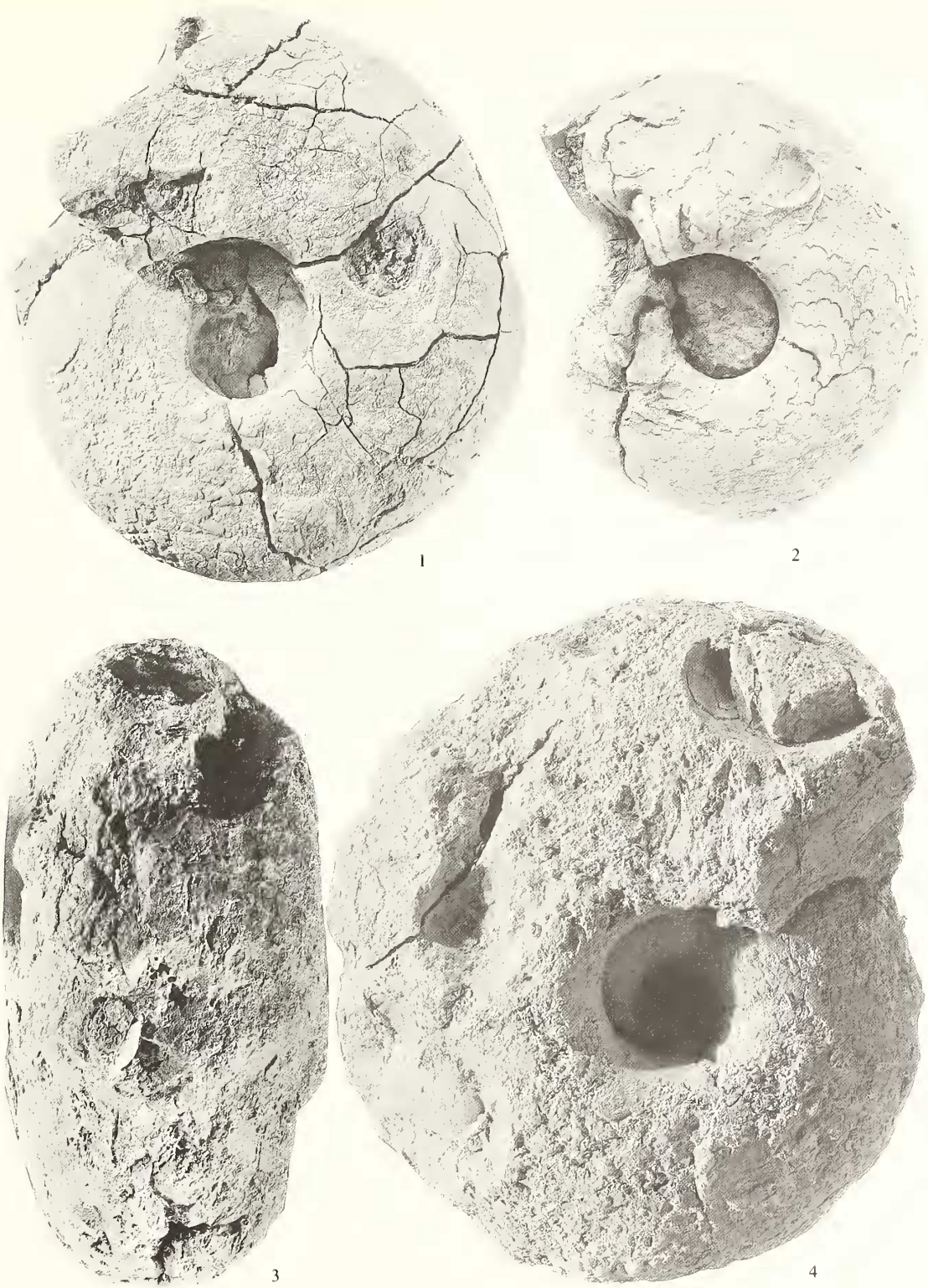
Material. Five internal moulds of phragmocones (SFB C307–C311), all in rather poor preservation. Dimensions could not be determined.

Description. Shell moderately evolute, slightly compressed. Moderately large umbilicus with rounded shoulders and vertical walls. Whorl section rounded, with rounded venter and converging flanks. Ornamentation consists of five to six strong umbilical nodes from which one or two diverging, slightly sinous prorsiradiate ribs arise which strengthen while crossing the venter. Minor ribs, arising on the flanks, are intercalated in irregular distances. Suture line see text-fig. 6c.

Discussion. In a revision of Choffat's (1898) vascoceratids, based on morphometrical studies, Berthou *et al.* (1975) regarded *V. gamai* var. *subtriangularis*, *V. adonensis*, *V. grossouvrei*, and *V.*

EXPLANATION OF PLATE 42

Fig. 1. *Vascoceras cauvini* Chudeau. SFB C294, specimen with partly preserved body-chamber, section 5, upper Galala Formation, late Cenomanian.
Fig. 2. *V.* cf. *cauvini* Chudeau. SFB C305, section 7, upper Galala Formation, late Cenomanian.
Figs. 3 and 4. *V. rumeaui* (Collignon). SFB C289, section 7, upper Galala Formation, late Cenomanian.
All figures × 1.



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LUGER and GRÖSCHKE, *Vascoceras*

mundae as synonyms of *V. gamai* (see also Berthou *et al.* 1985). This concept is followed herein and adopted in synonymy. The specimen figured by Douvillé (1928, fig. 3; pl. 1, fig. 4) is almost identical to our forms. In the present material *V. gamai* is represented only by juvenile specimens.

Occurrence. Upper Galala Formation: Section 5 (SFB C307, C309, C310) and section 6 (SFB C308, C311). Late Cenomanian.

In its Portuguese type area *V. gamai* is known from Choffat's beds 'E' to 'L' (late Cenomanian), but is most abundant in bed 'F' (*geslinianum* Zone, late Cenomanian, see Berthou *et al.* 1985, p. 70). Furthermore, it is known from the late Cenomanian to early Turonian of North Africa (Douvillé 1928; Amard *et al.* 1981; Collignon 1957, 1965) and according to Berthou *et al.* (1985) from Spain, Mexico, and Brasil.

Vascoceras rumeaui (Collignon, 1957)

Plate 41, figs. 5 and 6; Plate 42, figs. 3 and 4; text-fig. 8D

1957 *Paravascoceras rumeaui* Collignon, p. 10, pl. 1, fig. 2.
1969 *Paravascoceras rumeaui* Collignon; Freund and Raab, p. 21, pl. 3, figs. 4 and 5; text-fig. 5*c*, *d*.

Material. Four specimens (SFB C288–C291). Two of them almost complete internal moulds, in which the body-chamber is preserved up to a length of half a whorl.

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C288	110	0·52	0·50	0·22
SFB C289	111	0·45	—	0·20

Description. Shell moderately evolute, weakly depressed. Deep umbilicus fairly wide with rounded shoulders and vertical walls. Whorl section rounded and wider than high on phragmocone and inner part of body-chamber; on outer part of body-chamber suboval with faintly flattened outer flanks and almost as wide as high (text-fig. 8D). Ornamentation consists exclusively of strong fold-like prorsiradiate ribs on body-chamber, which are strongest on outer flanks and venter and weaken on the inner flanks. Suture line only poorly preserved.

Discussion. V. rumeaui apparently varies in the degree of inflation. Whereas the present specimens closely resemble the holotype in the height/width ratio (see Collignon 1957, p. 10, pl. 1, fig. 2), Freund and Raab (1969, pl. 3, figs. 4 and 5; text-fig. 5*c*) figured and described a more depressed form. *V. rumeaui* differs from *V. chevalieri* Furon, 1935, which has a similar cross-section and coiling-mode, in the lack of ornamentation on the phragmocone and the inner part of the body-chamber. *V. rumeaui* was regarded as a junior synonym of *V. cauvini* Chudeau, 1909 by Schöbel (1975). We cannot follow Schöbel's view since in the present material *V. rumeaui* differs from *V. cauvini* in its considerably more inflated cross-section and the narrower umbilicus. For comparison with other species see Freund and Raab (1969, p. 23).

Occurrence. Upper Galala Formation: Section 5 (SFB C290, C291) and section 7 (SFB C288, C289). Latest Cenomanian or (?)earliest Turonian.

V. rumeaui was originally described from Libya, where it was assigned to the early Turonian (Collignon 1957). It is reported from the *cauvini* Zone of the southern Negev (Freund and Raab 1969), which is now assigned to the latest Cenomanian by Kennedy *et al.* (1987).

EXPLANATION OF PLATE 43

Figs. 1 and 2. *Vascoceras durandi* (Thomas and Peron). SFB C292, section 7, upper Galala Formation, basal Turonian or ?latest Cenomanian.

Fig. 3. *V.* cf. *cauvini* Chudeau. SFB C306, section 7, upper Galala Formation, late Cenomanian.

Fig. 4. *Thomasites compressus* (Barber). SFB C314, section 5, upper Galala Formation, late Cenomanian or earliest Turonian.

All figures × 1.

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LUGER and GRÖSCHKE, *Vascoceras*, *Thomasites*

Subfamily PSEUDOTISSOTIINAE Hyatt, 1903
Genus THOMASITES Pervinquière, 1907

Type species. Pachydiscus rollandi Peron, 1890, p. 25, pl. 17, figs. 1–3, by original designation of Pervinquière (1907).

Remarks. Wright and Kennedy (1981, p. 98) discussed the genera *Gombeoceras* Reyment, 1954, *Koulabiceras* Atabekjan, 1966, and *Ferganites* Stankievich and Pojarkova, 1969 and regarded them as synonyms of *Thomasites* Pervinquière, 1907.

Thomasites compressus (Barber, 1957)

Plate 43, fig. 4; text-figs. 6B and 8E

1957 *Gombeoceras gongilense compressum* Barber, p. 41, pl. 19, figs. 2 and 5; pl. 33, figs. 15 and 16.
1978 *Gombeoceras compressum* Barber; Offodile and Reyment, p. 59, fig. 33.

Material. Two internal moulds (SFB C314–C315), one of them with parts of the body-chamber.

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C314	77	0·55	0·39	0·12

Description. Shell involute, compressed. Umbilicus small with angularly rounded shoulders and vertical walls. Venter narrow and tabulate on inner to subrounded on outer whorl (text-fig. 8E). Flanks flat on inner to slightly convex on outer whorl. Ornamentation only faintly visible, consisting exclusively of minor ventrolateral tubercles. Suture line see text-fig. 6B.

Discussion. The present specimens very closely resemble the type material as figured by Barber (1957, pl. 19, figs. 2 and 5; pl. 33, figs. 15 and 16). They differ slightly from it in their more convex flanks and the weaker ornamentation. The lack of feeble ribs in the present material may be due to wind erosion. The species was originally assigned to *Gombeoceras*, which is now placed under synonymy with *Thomasites* (see Wright and Kennedy 1981). The assignment of the species to *Thomasites* remains somewhat doubtful because it is unknown whether it bears umbilical tubercles on the early whorls.

Occurrence. Upper Galala Formation: Section 5. Latest Cenomanian or earliest Turonian.

The species is known from Nigeria (Barber 1957; Offodile and Reyment 1978) where species of '*Gombeoceras*' Reyment, 1954 (now *Thomasites*) are restricted to the *costatum* Zone (Barber 1957). The *costatum* Zone is placed in the early Turonian by Popoff *et al.* (1986) and in the late Cenomanian by Kennedy *et al.* (1987).

Thomasites cf. *subtenue* (Reyment, 1954)

cf. 1954 *Gombeoceras subtenue* Reyment, p. 261, pl. 4, fig. 4; text-fig. 3*f*.
cf. 1957 *Gombeoceras gongilense subtenue* Reyment; Barber, p. 43, pl. 19, fig. 4; pl. 20, fig. 3; pl. 24, fig. 3; pl. 33, figs. 13–14, 17.

Material. One poorly preserved internal mould with body-chamber of little more than half a whorl (SFB C313). Dimensions could not be determined.

Description. Shell involute, compressed. Small umbilicus with angularly rounded shoulders and steep walls. Cross-section highly arched with rounded venter and almost flattened flanks. Ornamentation consists of weak ribs rising on the outer flanks, crossing the venter. Ribs thicken ventrolaterally to form elongated short nodes. Ornamentation on outer part of body-chamber not observable. Suture line only poorly preserved.

Discussion. The present specimen closely resembles '*Gombeoceras*' *subtenue* Reyment, 1954. It is, however, slightly more compressed than Reyment's holotype. The ornamentation of the juvenile stage is not observable due to the poor preservation. *T. subtenue* differs from *T. compressus* (Barber, 1957) in its rounded venter and stronger ornamentation.

Occurrence. Upper Galala Formation: Section 7. Latest Cenomanian.

T. subtenue was originally described from Nigeria (Reyment 1954; Barber 1957); see also *T. compressus*.

Family TISSOTIIDAE Hyatt, 1900
Subfamily TISSOTIINAE Hyatt, 1900
Genus METATISSOTIA Hyatt, 1903

Type species. Ammonites fourneli Bayle, 1849, p. 360, pl. 17, figs. 1–5, by subsequent designation of Roman (1938).

Metatissotia fourneli (Bayle, 1849)

Plate 45, figs. 2 and 3; text-fig. 10F–G

1849 *Ammonites fourneli* Bayle, p. 360, pl. 17, figs. 1–5.
1897 *Tissotia fourneli* Bayle emend. Thomas et Peron; Peron, p. 59, pl. 10, figs. 1–8; pl. 17, figs. 9 and 10.
1897 *Tissotia grossouvrei* Peron, p. 70, pl. 16, figs. 1 and 2; pl. 18, fig. 17.
1903 *Metatissotia fourneli* (Bayle); Hyatt, p. 45.
1903 *Paratissotia grossouvrei* (Peron); Hyatt, p. 50.
1907 *Tissotia fourneli* Bayle; Pervinquière, p. 372, pl. 26, fig. 5.
?1915 *Tissotia fourneli* Bayle; Greco, p. 225, pl. 21, fig. 6.
1956 *Tissotia fourneli* (Bayle); Benavides-Cáceres, p. 480, pl. 62, figs. 3 and 4.

Material. Ten internal moulds (SFB C345–C354). Five specimens with partly preserved body-chamber of up to half a whorl. Diameter of largest specimen is 162 mm.

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C351	76	0·47	—	0·15
SFB C354	80	0·55	—	0·14

Description. Shell involute, rather strongly depressed (text-fig. 10F, G). Pronounced sharp keel which disappears slowly on body-chamber. Umbilical shoulder rounded. Ornamentation in general not strongly developed. Consists at first of radial ribs, beginning on umbilical node-like undulations and ending at ventrolateral, sometimes clavi-like, nodes. Single intercalatory ribs are present, also ending in ventrolateral nodes. Later ribs disappear, finally on body-chamber only in the umbilical region vague coarse radial folds are developed. Suture line only poorly preserved.

Discussion. M. fourneli apparently varies in the degree of depression of the shell. Whereas Peron (1897, pl. 10, figs. 1–8; pl. 17, figs. 9 and 10) figured relatively compressed specimens, Pervinquière (1907, p. 372, pl. 26, fig. 5) reported a more depressed form. Also the measurements of additional, unfigured specimens given by Pervinquière (1907, p. 372) were derived from depressed forms. The measurements of the present specimens closely resemble those given by Pervinquière (1907). The whorl sections of the studied specimens also resemble *Tissotia grossouvrei* Peron, 1897 (pl. 16, figs. 1 and 2). *T. grossouvrei* differs from *T. fourneli* only in its slightly weaker ornamentation, so that, as already mentioned by Pervinquière (1907, p. 374), a differentiation of the two forms cannot be justified. *M. fourneli* differs from the likewise depressed *Subtissotia africana* (Peron, 1897) in the presence of umbilical sculptural elements. *M. nodosa* Hyatt, 1903 differs from *M. fourneli* in the presence of flexuous ribs. *M. ewaldi* (von Buch, 1848) *sensu* Kennedy (1984*b*) is much more compressed, has a fastigiate venter, and generally shows a weaker ornamentation than *M. fourneli*.

Occurrence. Hawashya Formation: Lower transgressive sequence, section 7. Middle or late Coniacian.

M. fourneli is known from Algeria and Tunisia, poorly dated as Coniacian or 'lower Senonian' (Peron 1897; Pervinquière 1907), from the Coniacian of Peru (Benavides-Cáceres 1956), and is reported from the late Coniacian of the Middle East (Lewy and Raab 1978).

Metatissotia cf. *ewaldi* (v. Buch, 1848)

Plate 44, figs. 1 and 2; text-fig. 10E

cf. 1848 *Ammonites ewaldi* von Buch, p. 221, pl. 1, fig. 4.
cf. 1984*b* *Metatissotia ewaldi* (von Buch); Kennedy, p. 127, pl. 28, figs. 4 and 5; pl. 29, figs. 9–11; pl. 30, figs. 1–2, 5–6, 8–9, 12; pl. 32, figs. 1–3; text-fig. 40B, E (see here for further synonymy).

Material. One adult specimen with partly preserved body-chamber (SFB C355).

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C355	131	0·53	—	0·06

Description. Very involute compressed shell. Umbilical shoulder rounded with a steep wall. Venter nearly fastigiate, slowly becoming rounded on body-chamber. On phragmocone ornamentation consists of faint marginal ribs which end in ventrolateral clavi. No ornamentation visible on body-chamber. Suture line only partly preserved (see text-fig. 10E).

Discussion. The present specimen closely resembles the one figured by Kennedy (1984*b*, pl. 29, figs. 9–11). The author notes (Kennedy 1984*b*, p. 127): 'The line of the clavi is marked by a distinct facet so that the very narrow angle of the projected flanks is replaced by a less acute, fastigiate venter.' This 'facet', which is clearly visible almost on all specimens figured by him, cannot be observed on the investigated specimen. Therefore, the present specimen cannot be assigned unequivocally to the species *M. ewaldi* (von Buch).

Occurrence: Hawashya Formation: Lower transgressive sequence, section 7. Middle or late Coniacian.

M. ewaldi is known from the middle Coniacian of France, northern Spain, and Austria (Kennedy 1984*b*). The species is also reported from the late Coniacian of Sinai and Israel (Lewy and Raab 1978).

Metatissotia sp.

Plate 45, figs. 4 and 5; text-fig. 10H

Material. One internal mould of phragmocone (SFB C356).

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C356	81	0·54	0·68	—

Description. Shell inflated with narrow umbilicus. Whorl section broadly rounded, venter occupied by strong, clearly set-off keel (see text-fig. 10H). Ornamentation consists of few umbilical nodes and more numerous node-like elevated ventrolateral clavi. The relation between the number of umbilical nodes and clavi is not clear due to the poor preservation of the specimen. Each umbilical node is connected with one of the clavi by a short straight fold-like rib. Short intercalatory ribs arising from the clavi are present. Suture line not preserved.

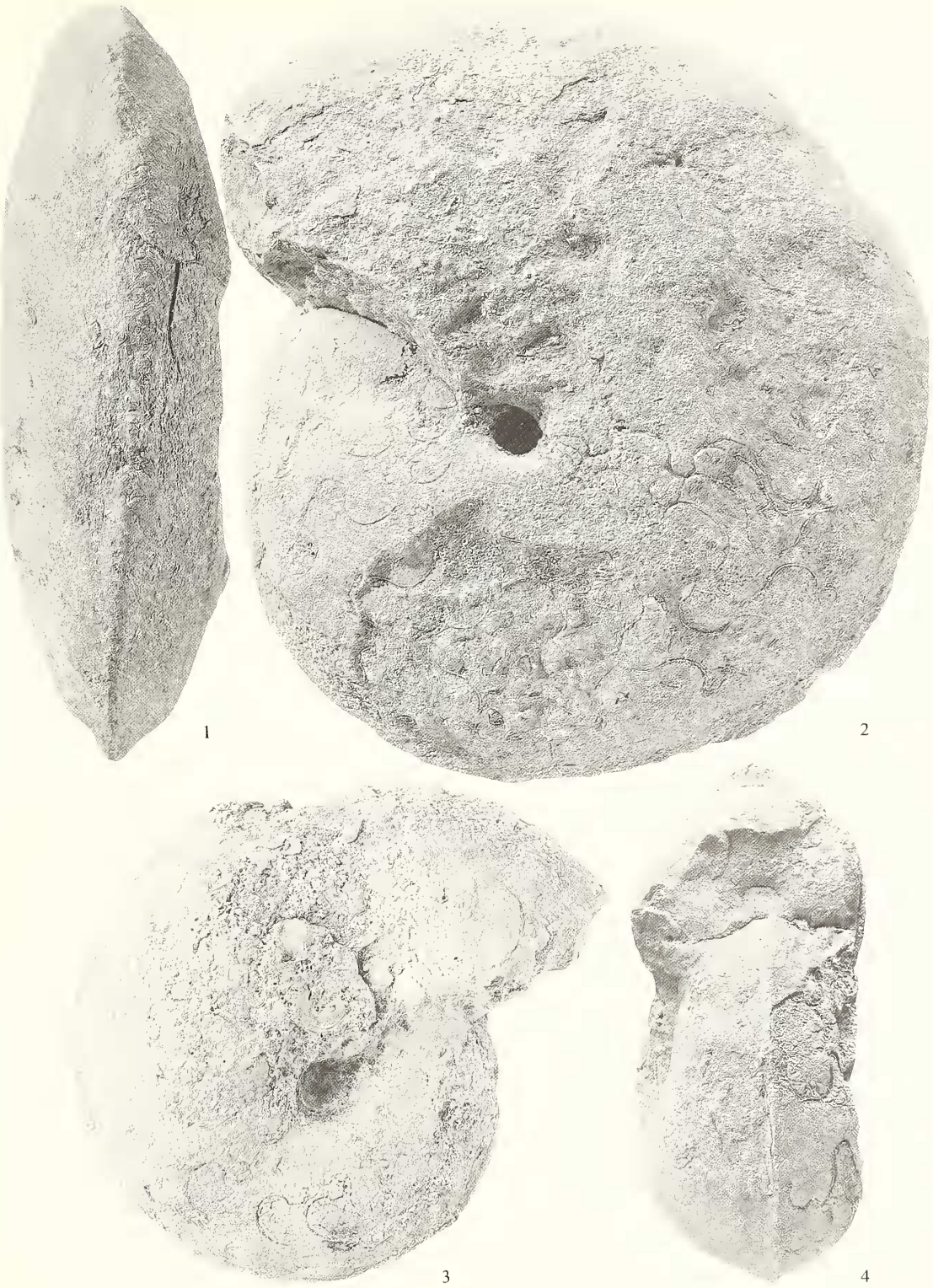
Discussion. The present specimen cannot be assigned to a certain species of *Metatissotia* due to the strong inflation of phragmocone. It differs from the likewise inflated *S. africana* (Peron, 1897) in the presence of umbilical nodes.

Occurrence: Hawashya Formation: Lower transgressive sequence, section 7. Middle or late Coniacian.

EXPLANATION OF PLATE 44

Figs. 1 and 2. *Metatissotia* cf. *ewaldi* (von Buch). SFB C355.
Figs. 3 and 4. *Subtissotia africana* (Peron). SFB C357.

Both species from section 7, lower transgressive sequence of Hawashya Formation, middle or late Coniacian, × 1.



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LUGER and GRÖSCHKE, *Metatissotia, Subtissotia*

Genus SUBTISSOTIA Hyatt, 1903

Type species. *Tissotia tissoti* var. *inflata* Peron, 1897, p. 68, pl. 12, fig. 6, by original designation of Hyatt (1903).

Subtissotia africana (Peron, 1897)

Plate 44, figs. 3 and 4; Plate 45, fig. 1; text-fig. 9

1897 *Tissotia ewaldi* de Buch var. *africana* Peron, p. 63, pl. 11, figs. 5 and 6; pl. 17, fig. 12 (*non* pl. 11, figs. 1–4; pl. 17, fig. 11).
1903 *Subtissotia africana* (Peron); Hyatt, p. 44.

Lectotype. Peron (1897, pl. 11, figs. 5 and 6, lectotype designated here, see below).

Material. Four internal moulds (SFB C357–C360). Body-chamber preserved up to half a whorl in two specimens.

TEXT-FIG. 9. *Subtissotia africana* (Peron). SFB C360, section 7, lower transgressive sequence of Hawashya Formation, middle or late Coniacian, ×1.

EXPLANATION OF PLATE 45

Fig. 1. *Subtissotia africana* (Peron). SFB C358.
Figs. 2 and 3. *Metatissotia fourneli* (Bayle). SFB C354.
Figs. 4 and 5. *Metatissotia* sp. SFB C356.

All from section 7, lower transgressive sequence of Hawashya Formation, middle or late Coniacian, ×1.

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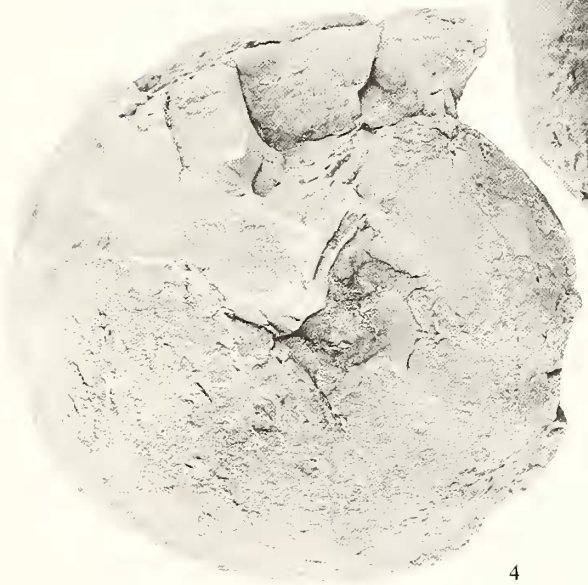

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LUGER and GRÖSCHKE, *Subtissotia*, *Metatissotia*

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C357	88	0·52	—	0·10
SFB C360	115	0·64	—	0·07

Description. Shell involute. Umbilical shoulder rounded. Whorl section variable, moderately depressed. Flanks flat to rounded. Phragmocone with sharp, pronounced keel, body-chamber rounded in ventral aspect, without keel. Ornamentation in general weak, at first with ventrolateral clavi situated close to the keel, from which short, vague broad radial folds arise, terminating in the upper third of the height of whorl. Later, only vague broad radial folds are to be recognized. The body-chamber is smooth, as far as can be observed due to the state of preservation. In general, no sculptural elements are visible on the flanks or the umbilical region. Suture line only poorly preserved.

Discussion. The three specimens figured by Peron (1897, pl. 11, figs. 1–6) differ considerably in shape. Therefore, their attribution to one and the same species may be doubted. A small, strongly depressed form (Peron 1897, pl. 11, figs. 5 and 6) and two more compressed forms (Peron 1897, pl. 11, figs. 1–4) face one another. A holotype was not designated by Peron (1897). Hyatt (1903), although he differentiated *Tissotia* on subgeneric level and redescribed the species erected by Peron (1897), did not define a lectotype. The present material closely resembles the specimen figured by Peron (1897, pl. 11, figs. 5 and 6) as regards ornamentation and shape. Therefore, we would like to suggest this specimen as the lectotype of *S. africana* (Peron, 1897) and exclude the other figured specimen (Peron 1897, pl. 11, figs. 1–4) from this species.

S. africana differs from the likewise depressed *M. fourneli* (Bayle, 1849) in its lack of any umbilical sculptural elements. It can be distinguished from *S. inflata* (Peron, 1897) and *S. intermedia* (Peron, 1897) by the absence of the keel-like elongated ventral ridges and the less inflated phragmocone. *M. ewaldi* (von Buch, 1848) is more compressed than *S. africana.*

Occurrence. Hawashya Formation: Lower transgressive sequence, section 7. Middle or late Coniacian.

The species was originally described from Tunisia where it was tentatively assigned to the 'lower Senonian' by Hyatt (1903).

Family COILOPOCERATIDAE Hyatt, 1903
Genus COILOPOCERAS Hyatt, 1903

Type species. Coilopoceras colleti Hyatt, 1903, p. 91, pl. 10, figs. 5–21; pl. 11, fig. 1, by original designation.

Coilopoceras requienianum (d'Orbigny, 1841)

Plate 46, figs. 1–3; text-figs. 6A, E, 11, 12, 13A–C

1841 *Ammonites requienianum* d'Orbigny, p. 315, pl. 93, figs. 1–4.
1903 *Coilopoceras requienianum* (d'Orbigny); Hyatt, p. 99.
?1975 *Coilopoceras sinaiense* Lewy, p. 42, pl. 1, fig. 3; fig. 15I–L.
?1975 *Coilopoceras multicostatum* Lewy, p. 42, pl. 1, figs. 1 and 2; fig. 15A–D, H.
1984 *Coilopoceras requienianum* (d'Orbigny); Kennedy and Wright, p. 282, pls. 35–36; text-figs. 1–5 (see here for further synonymy).

Material. Sixteen internal moulds (SFB C329–C344). Five of them with parts of body-chamber preserved up to a length of three-quarters of a whorl.

EXPLANATION OF PLATE 46

Figs. 1–3. *Coilopoceras requienianum* (d'Orbigny). SFB C331, smooth specimen. 2, view on side affected by wind erosion, umbilicus enlarged by weathering. 3, view on opposite side, where sediment was removed by manual preparation, umbilicus in natural size. Section 7, upper transgressive sequence of Umm Omeiyed Formation, late Turonian, ×1.

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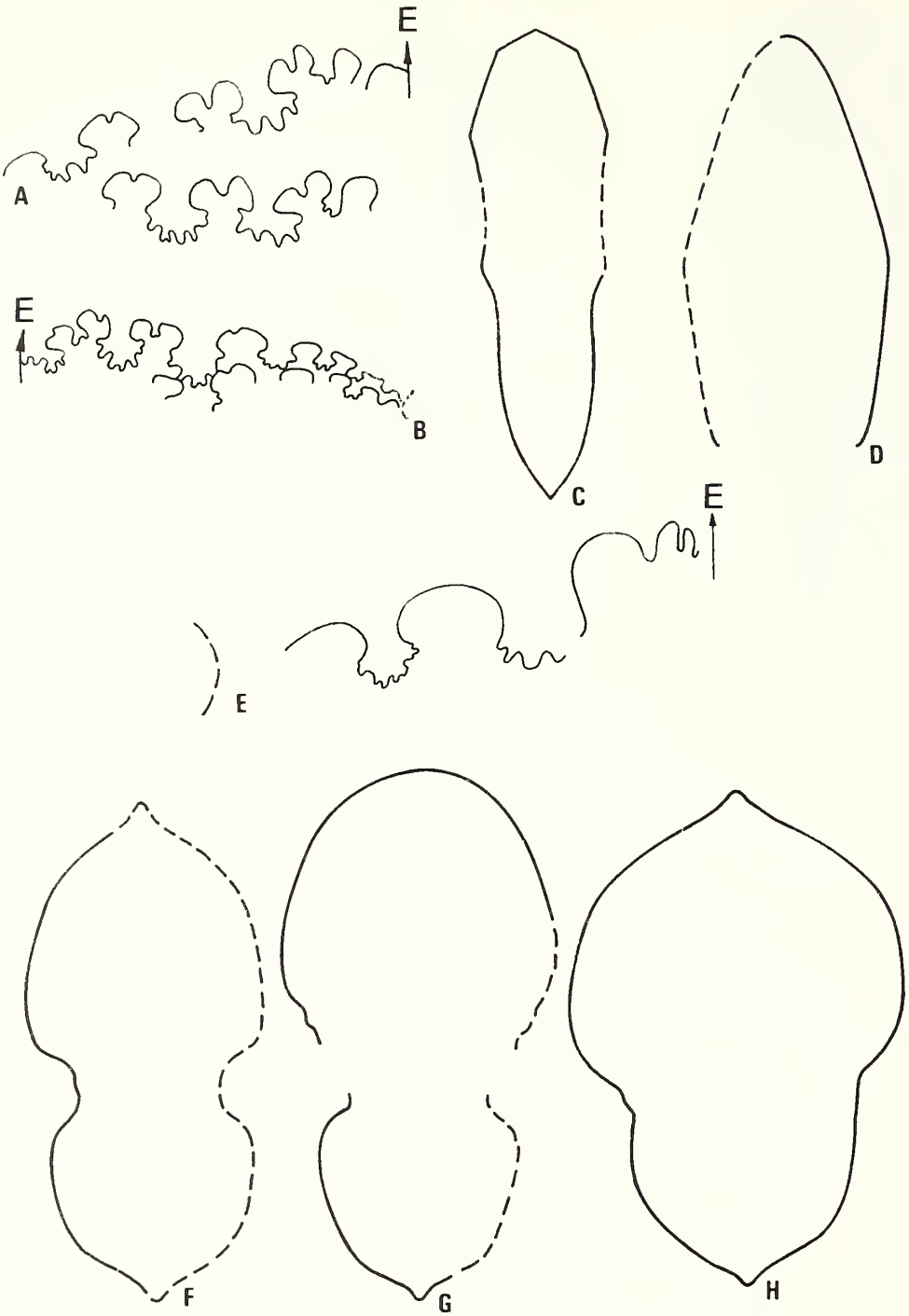
LUGER and GRÖSCHKE, *Coilopoceras*

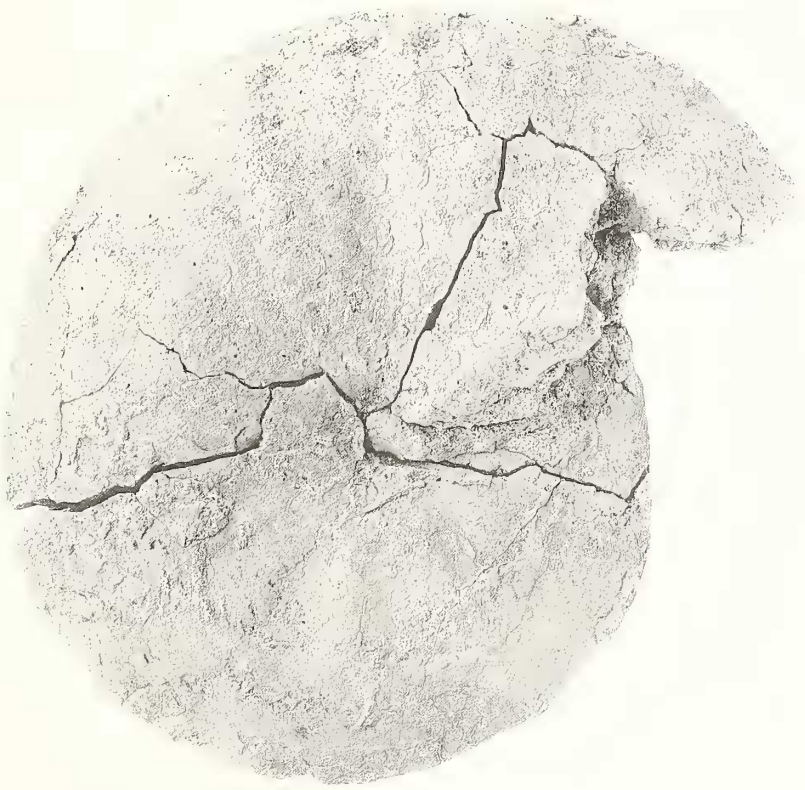


TEXT-FIG. 10. A–C, external sutures and whorl section of *Manambolites piveteaui* Hourcq. A, SFB C396, ×2·7; B, SFB C404, ×2·7; C, SFB C390, ×0·9. D, whorl section of *Libycoceras* sp. ex gr. *L. ismaeli* (Zittel), SFB C432, ×0·9. E, suture of *Metatissotia* cf. *ewaldi* (Buch), SFB C355, ×1·9. F, G, whorl sections of *M. fourneli* (Bayle). F, SFB C350, ×0·9; G, SFB C353, keel eroded on outer whorl, ×0·9. H, *Metatissotia* sp. SFB C356, ×0·9.

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C329	113	0·55	0·38	0·05
SFB C330	165	0·56	0·32	0·08
SFB C331	99	0·58	0·32	0·05

Description. In the investigated specimens two morphotypes, a smooth and a ribbed form of the species, occur. In the smooth form the shell is involute, oxycone. Whorl section lanceolate with a sharpened venter, maximum width close to umbilicus (text-fig. 13C). Umbilicus small, with rounded shoulders and almost vertical walls. The ribbed form is less compressed and the maximum width tends to be situated at the middle of the flanks (text-fig. 13A, B). Venter sharpened on phragmocone, becoming blunt on body-chamber. Ornamentation consists of almost straight, low ribs on inner whorls of phragmocone, which grade into low radial folds on the outer whorls of the phragmocone and early part of body-chamber. Single intercalatory ribs present. Ribs and folds are best developed on the middle flanks; ventral region is smooth. Suture line observed only in a few specimens (see text-fig. 6A, E).

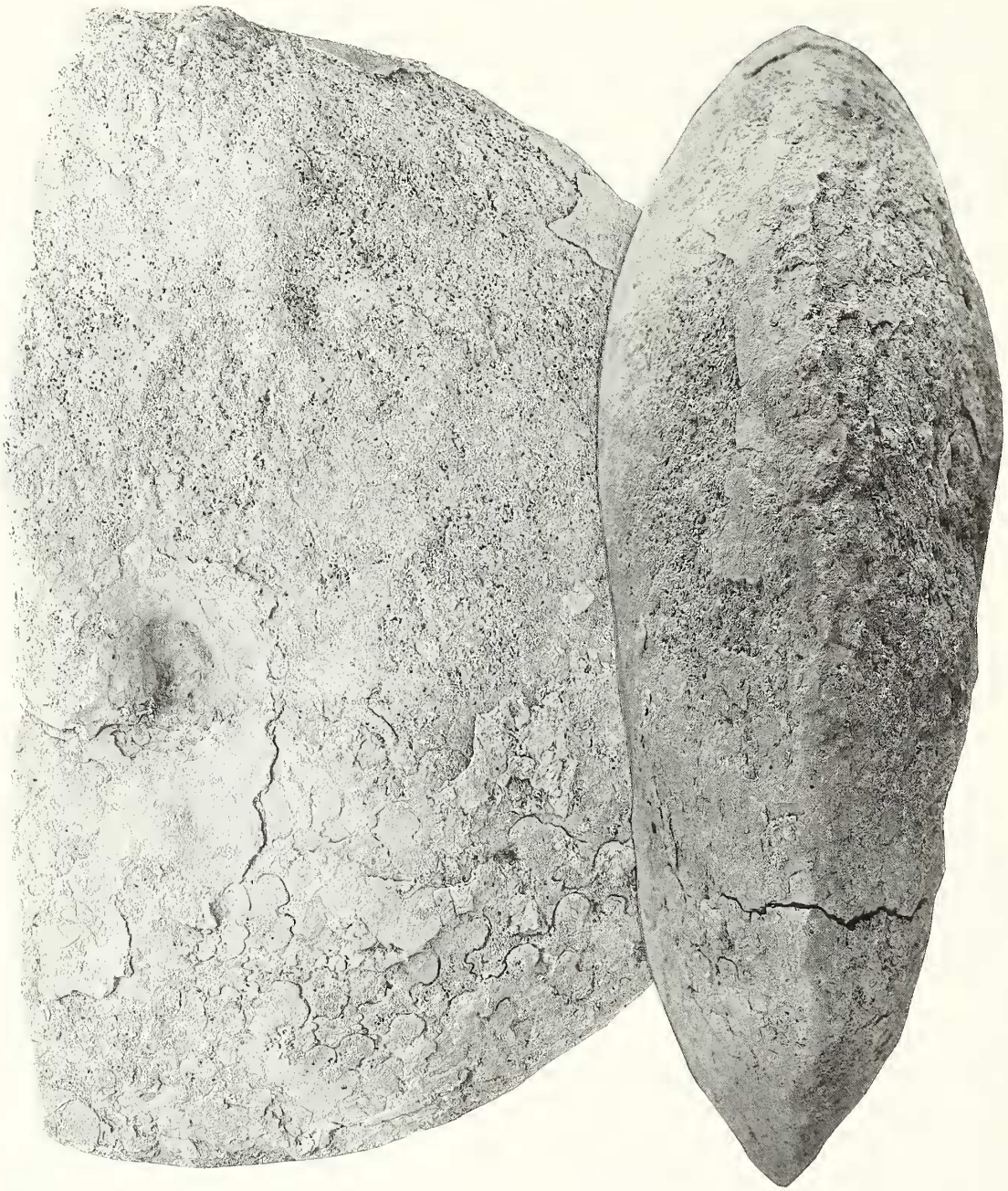


TEXT-FIG. 11. *Coilopoceras requienianum* (d'Orbigny). SFB C329, ribbed specimen, section 7, upper transgressive sequence of Umm Omeiyed Formation, late Turonian, × 1.

Discussion. Among the better preserved specimens of the investigated material the largest specimen of the smooth morphotype attain a maximum diameter of 96 mm. The ribbed specimens attain larger diameters (up to 220 mm).

The studied specimens agree well with the description and illustrations of Kennedy and Wright (1984, p. 283). In their redescription of the type-material of d'Orbigny (1841) these authors suggested the existence of sexual dimorphism in *C. requienianum* which is expressed as the existence of both smooth oxycones and ribbed, less compressed forms. This phenomenon is also reported from other species of *Coilopoceras* (Cobban and Hook 1980, p. 11).

The specimens figured by Lewy (1975) as *C. sinaiense* sp. nov. and *C. multicostatum* sp. nov. from the *requienianum* Zone of the Eastern Desert and Sinai show a close similarity with *C. requienianum*. Because of the poor state of preservation of the figured specimens, these species can only questionably be taken into synonymy with *C. requienianum*.



TEXT-FIG. 12. *Coilopoceras requienianum* (d'Orbigny). SFB C330, ribbed specimen, section 7, upper transgressive sequence of Umm Omeiyed Formation, late Turonian, × 1.

Occurrence. Umm Omeiyed Formation: Upper transgressive sequence of Umm Omeiyed Formation, section 7. Late Turonian. The present specimens of *C. requienianum* are mainly from two horizons of glauconitic calcareous sandstones, separated by about 8 m thick intercalations of clays, marls, and marly limestones in which only a few specimens have been recovered. Indeterminable fragments of *Coilopoceras* have also been found in the same stratigraphic position of section 4.

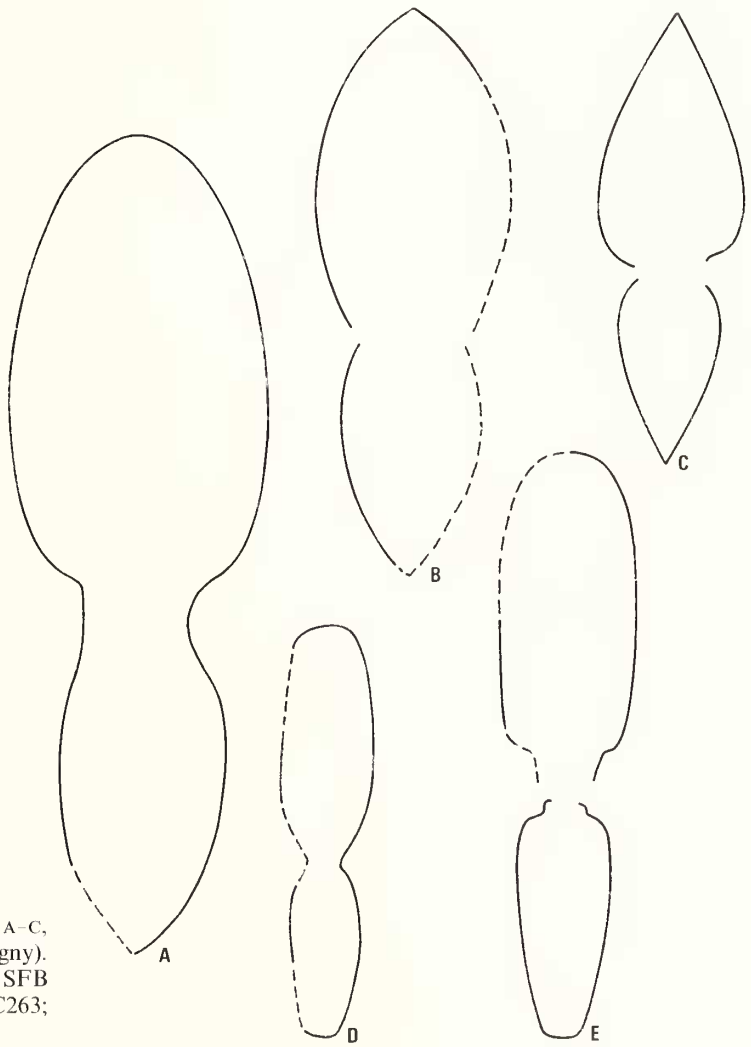
The species is known from the late Turonian of France and Germany (Kennedy and Wright 1984) and probably the Sinai (Lewy 1975).

Family SPHENODISCIDAE Hyatt, 1900
Genus MANAMBOLITES Hourcq, 1949

Type species. Manambolites piveteaui Hourcq, 1949, p. 111, pl. 3, fig. 1; figs. 20–22, by monotypy.

Manambolites piveteaui Hourcq, 1949

Plate 47, figs. 1–5; Plate 48, figs. 1 and 2; text-fig. 10A–C



TEXT-FIG. 13. Whorl section of: A–C, *Coilopoceras requienianum* (d'Orbigny). A, SFB C330; B, SFB C329; C, SFB C331. D, E, *Neolobites* sp. D, SFB C263; E, SFB C252. All ×0·67.

1949 *Manambolites piveteaui* Hourcq, p. 111, pl. 3, fig. 1; figs. 20–22.
?1953 *Coahuilites* (*Mzezzemceras*) *pervinquieri* Basse, p. 866, pl. 27, fig. 2.
1959 *Praelibycoceras* sp. 1; Faris and Hassan, pl. 2, fig. 1.
1959 *Praelibycoceras* sp. 2; Faris and Hassan, pl. 2, fig. 2.
?1959 *Libycoceras ismaeli* var. *safagensis* Faris and Hassan, p. 194, pl. 2, figs. 4 and 8.
1970 *Manambolites piveteaui* Hourcq; Collignon, p. 70, fig. 2341.

Material. Thirty-seven specimens (SFB C385–C421). Body-chamber of up to half a whorl preserved in ten specimens. Numerous fragments.

Dimensions.

	D	*Wh*	*Wb*	*U*
SFB C385	41	0·53	0·31	—
SFB C389	133	0·55	0·28	—
SFB C393	71	0·61	0·28	—
SFB C399	74	0·62	0·31	—
SFB C404	46	0·59	0·27	—
SFB C406	123	0·57	0·28	—
SFB C407	91	0·58	0·26	—

Description. Shell involute, oxycone, umbilicus extremely narrow (text-fig. 10c). Venter on phragmocone with very acute, sharp keel on body-chamber, broadening, becoming oval with smooth keel, fastigiate throughout. Ornamentation smooth, of varying intensity on different specimens. In early stages with short smooth, sickle-shaped ventrolateral riblets, which do not reach the venter. Later ventrolateral part of riblets is strongly bent forward to form ventrolateral clavi, which persist, but weaken, on body chamber. At the same growth stage a row of lateral tubercles of increasing intensity arise; lateral tubercles become smooth or vanish on body-chamber of large specimens. Fine sinuous growth striae are visible throughout on well-preserved specimens. Suture-line see text-fig. 10a–b.

Discussion. Among the present specimens assigned to this species, two morphologic varieties can be recognized. The smaller variety, form A (see Pl. 47, fig. 5; Pl. 48, fig. 1), is characterized by a broadening of the venter and a relatively strong ornamentation at an early stage. In specimens of form A the body-chamber is preserved and occupies at least one-half of the final whorl. These specimens do not exceed 91 mm in diameter; most of them have diameters between 70 and 80 mm. The second variety, form B (see Pl. 47, figs. 1–4), shows a weak ornamentation and a sharp keel up to a very late stage and the lateral tubercles are only faintly developed or absent. Form B is the large variety with diameters up to at least 123 mm (incomplete specimen). As both varieties are from one horizon and locality, show identical suture lines and mode of development, sexual dimorphism is assumed with the existence of a stronger ornamented microconch and a smoothly ornamented macroconch.

M. piveteaui differs from *M. dandensis* Howarth, 1965 from the late Campanian of Angola, which shows a very similar ornamentation, in details of the suture line (see Howarth, 1965, p. 397). *Coahuilites* (*Mzezzemceras*) *pervinquieri* Basse, 1953 may represent a slightly stronger ornamented variety of *M. piveteaui*, as already mentioned by Howarth (1965, p. 397). The genus *Praelibycoceras* Douvillé, 1912 from Tunisia, which is often cited in the Egyptian literature, is considered to be a synonym of *Eulophoceras* Hyatt, 1903 (Arkell *et al.* 1957). Nevertheless, it is very likely that most of the Egyptian forms attributed to *Praelibycoceras* belong to *M. piveteaui*.

EXPLANATION OF PLATE 47

Figs. 1–5. *Manambolites piveteaui* Hourcq. 1 and 2, SFB C389, almost smooth adult retaining keel until a late stage (form B). 3 and 4, SFB C396, almost smooth phragmocone with sharp keel (form B). 5, SFB C410, specimen showing relatively strong ornamentation, venter on body-chamber rounded (form A).

All specimens from section 2, basal phosphate horizon of Rakhiyat Formation, late middle Campanian, × 1.

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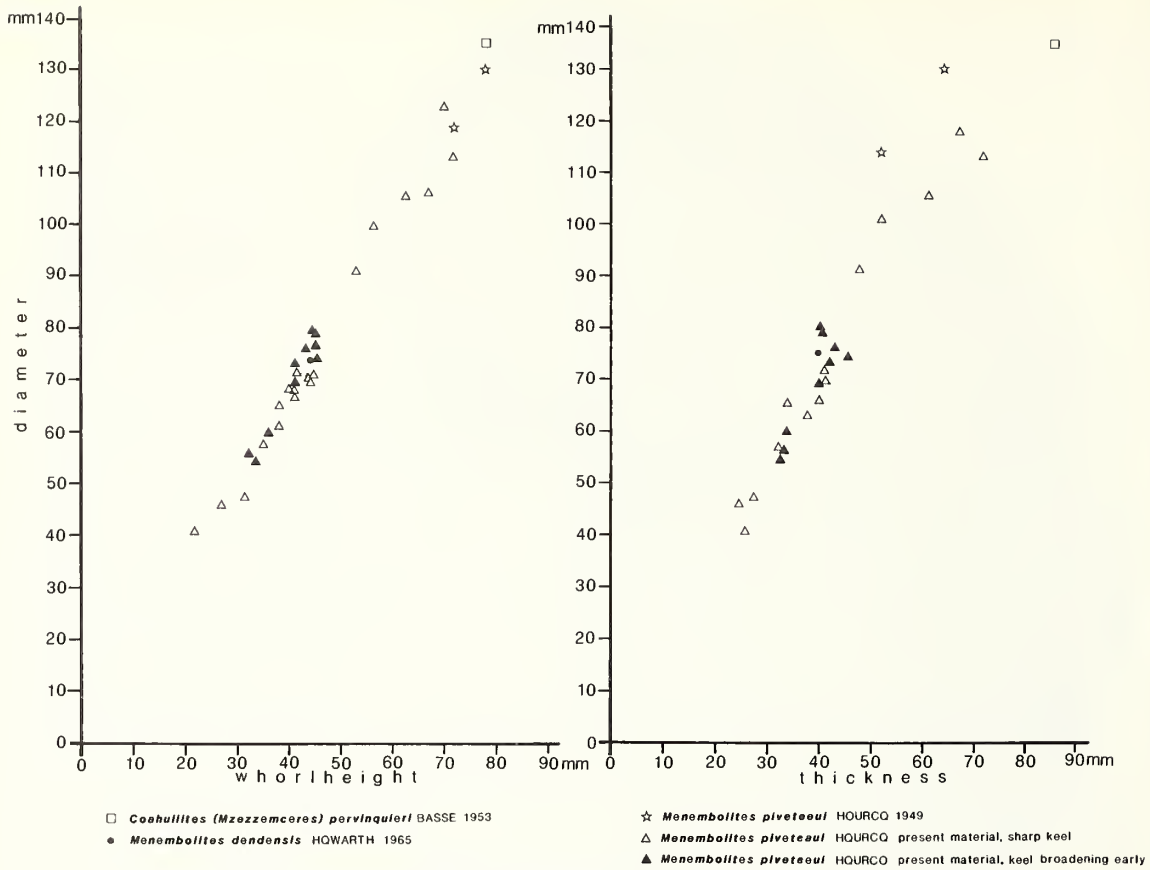
LUGER and GRÖSCHKE, *Manambolites*



TEXT-FIG. 14. Growth parameters of *Manambolites piveteaui* Hourcq and related forms.

Occurrence. Rakhiyat Formation: Unit 1, section 2. Late middle Campanian.

Aceording to Collignon (1970) the species is known from the late middle Campanian of Madagasear ('Zone of *Delawarella subdelawarensis* and *Australiella australis*').

Genus LIBYCOCERAS Hyatt, 1900

Type species. *Sphenodiscus ismaelis* Zittel, 1884, p. 451, fig. 631, by original designation of Hyatt (1900).

Libycoceras sp. ex gr. *Libycoceras ismaeli* (Zittel, 1884)

Plate 48, figs. 3–6; text-fig. 10D

EXPLANATION OF PLATE 48

Figs. 1 and 2. *Manambolites piveteaui* Hourcq. SFB C390, speeimen showing relatively strong ornamentation, venter on body-chamber rounded (form A), section 2, basal phosphate horizon of Rakhiyat Formation, late middle Campanian.

Figs. 3–6. *Libycoceras* sp. ex gr. *Libycoceras ismaeli* (Zittel). 3 and 6, SFB C435; 4 and 5, SFB C432. Both specimens from section 3 (Gebel Qreiya), upper Rakhiyat Formation, late Campanian.

All figures ×1.

1

2

3

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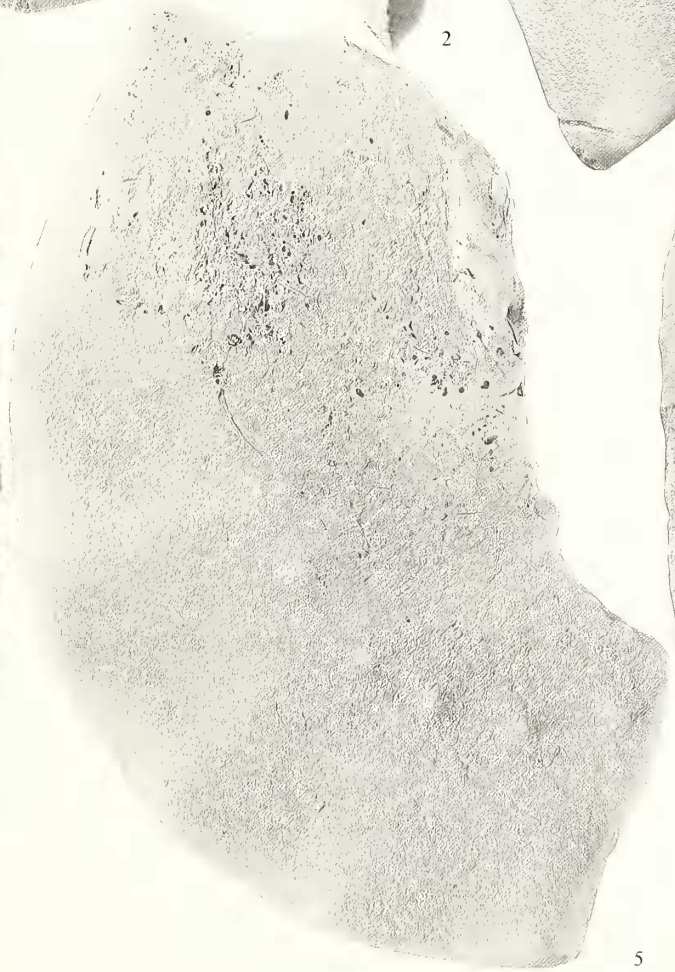


5

6

LUGER and GRÖSCHKE, *Manambolites*, *Libycoceras*

Material. Five fragmentary internal moulds of body-chambers (SFB C432–C436). Dimensions could not be determined.

Description. Shell involute, compressed. Umbilical region not preserved. Ornamentation consists of an inner row of tubercles and an outer row of nodes and broad undulations. The inner row is formed by small pointed tubercles, situated at about the middle of the flanks. The outer, ventrolateral row consists of strong clavi, which are less numerous than the inner tubercles. The area in between both rows is occupied by shallow undulations, which arise from the clavi and vanish before reaching the tubercles. The area between lateral tubercles and umbilicus is smooth. Whorl section high, subhexagonal, greatest width at about mid-height, where the row of lateral tubercles is situated (see text-fig. 10D). Venter acutely rounded with a faint keel; nearly tabulate between the clavi. The tabulate venter is more pronounced on the outer part of the body-chamber. Suture line not well preserved.

Discussion. The present specimens closely resemble *L. ismaeli* (Zittel, 1884), from which they differ in showing an almost tabulate venter between the ventrolateral nodes. In true *L. ismaeli* the venter is keeled throughout the phragmocone in specimens which are larger than the present material, as figured by Quaas (1902, pl. 30, fig. 1).

Occurrence. Rakhiyat Formation: Unit 3, about 1 m below the assemblage of heteromorphic ammonites, section 3. Late Campanian.

Suborder ANCYLOCERATINA Wiedmann, 1966
Superfamily TURRILITACEA Gill, 1871
Family BACULITIDAE Gill, 1871
Genus BACULITES Lamarck, 1799

Type species. Baculites vertebralis Lamarck, 1801, p. 103, by subsequent designation of Meek (1876).

Baculites cf. *ovatus* Say, 1820

Plate 49, fig. 2; text-fig. 15I–O

cf. 1820 *Baculites ovata* Say, p. 41.
cf. 1962 *Baculites ovatus* Say; Reeside, p. 113, pl. 68, figs. 1–4.
cf. 1974 *Baculites ovatus* Say; Cobban, p. 3, pl. 1, figs. 1–32; pl. 2, figs. 1–14; pl. 3, figs. 1–6, 9–11; fig. 4 (see here for further synonymy).

Material. Seventeen fragments (SFB C427). Dimensions could not be determined.

Discussion. The present material consists of small, poorly preserved body-chamber fragments of different growth stages. Suture line preserved in three specimens (see text-fig. 15O). The largest fragment has a length of 75 mm, a height of 22 mm, and a width of 17·5 mm at its broader and of 19 mm and 14·5 mm at its smaller end, respectively. The investigated specimens show an almost perfect oval cross-section (see text-fig. 15I–N) and their surface is smooth to very faintly ribbed. Thus they closely resemble *B. ovatus*, but due to their poor preservation, they can only be compared with this species.

EXPLANATION OF PLATE 49

Fig. 1. *Baculites subanceps* Haughton. SFB C470.
Fig. 2. *B.* cf. *ovatus* Say. SFB C427.
Figs. 3 and 4. *Solenoceras humei* (Douvillé). 3, SFB C467; 4, SFB C468.
Figs. 5, 9–10. *Nostoceras* (*Nostoceras*) sp. 5, SFB C452; 9 and 10, SFB C437; both specimens are body-chambers.
Figs. 6–8. *N.* (*Planostoceras*) sp. 6, SFB C460, fragment of phragmocone, view on the base of spire. 7, SFB C463, plastic cast of phragmocone, view on the top of spire. 8, SFB C457; body-chamber.
All specimens from sections 1–3 (Gebel Qreiya), Rakhiyat Formation, Campanian, ×1.

LUGER and GRÖSCHKE, *Baculites*, *Solenoceras*, *Nostoceras*

Occurrence. Rakhiyat Formation: Unit 1, section 2. Late middle Campanian.

The species is known from the late Campanian to early Maastrichtian of the United States (Cobban 1974).

Baculites subanceps Haughton, 1925

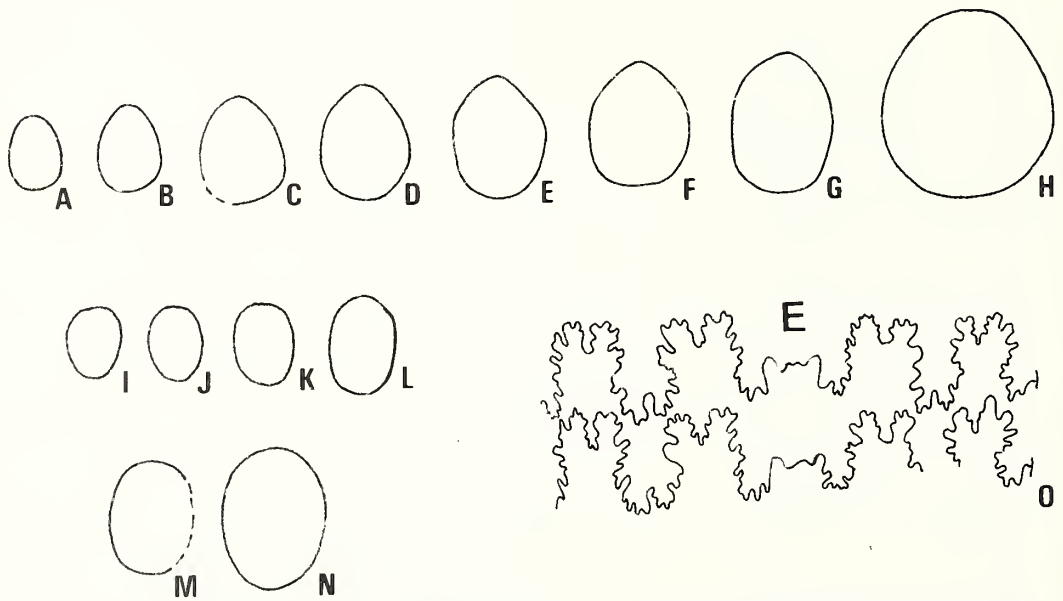
Plate 49, fig. 1; text-fig. 15A–H

1925 *Baculites subanceps* Haughton, p. 278, pl. 14, figs. 6–8.
1965 *Baculites subanceps* Haughton; Howarth, p. 368, pl. 5, fig. 3; pl. 6, figs. 6 and 7; pl. 7, fig. 1; figs. 4, 13–15 (see here for further synonymy).

Material. Thirty-six fragments of body-chambers (SFB C470). Dimensions could not be determined.

Discussion. The present material consists of mainly poorly preserved body-chambers of different growth stages, the largest of them has a length of 80 mm, width of 24 mm, and height of 28 mm. The better preserved specimens show the characteristic ornamentation and cross-section (see text-fig. 15A–H) as described by Howarth (1965). Probably due to the poor preservation, most of the present specimens do not show the crenulated ribs crossing the slightly sharpened, unkeeled venter.

B. anceps pacificus Matsumoto and Obata, 1963 was treated as a subspecies of *B. subanceps* by Howarth (1965), although he noted (Howarth 1965, p. 370): 'Comparison of the holotype of *pacificus* (Matsumoto 1959*a*: pl. 34, fig. 3) with the lectotype of *subanceps* (pl. 6, fig. 6) shows that *pacificus* has between two and three times as many arcuate ribs as *subanceps*.' Howarth (1965, p. 405) attributed the specimens of *B. subanceps* from Carimba (Angola) to the latest Campanian (*polyplocum* Zone). *B. anceps pacificus* was reported as a valid species by Ward (1978) from the late middle to early upper Campanian (*pacificum* and *vancouverense* Zones) of the Vancouver Island region (Canada). Due to the differences in ornamentation, as already expressed by Howarth (1965), and the differing stratigraphic occurrence we cannot follow Howarth's view and suggest keeping the two forms separate.



TEXT-FIG. 15. A–H, whorl sections of *Baculites subanceps* Haughton. Based on eight specimens, SFB C470*a–h*, ×1. I–O, whorl sections and suture of *B.* cf. *ovatus* Say. Whorl sections based on six specimens, C427*a–f*, ×1. Suture, SFB C470*d*, ×3.

Occurrence. Rakhiyat Formation: Unit 3, section 3, late Campanian.

The species is known from the late Campanian of Angola (Howarth 1965).

Family NOSTOCERATIDAE Hyatt, 1894
Genus NOSTOCERAS Hyatt, 1894
Subgenus NOSTOCERAS Hyatt, 1894

Type species. Nostoceras stantoni Hyatt, 1894, p. 569, by original designation.

Nostoceras (*Nostoceras*) spp.

Plate 49, figs. 5, 9–10

Material. Sixteen sinistrally and dextrally coiled fragments (SFB C437–C452). Dimensions could not be determined.

Discussion. The present fragments of hook-shaped body-chambers differ only in size. The whorl height increases very slightly from the initial part of body-chamber to the aperture (20·5 mm to 21·5 mm in the best preserved specimen). The ornamentation consists of strong ribs, each bearing widely spaced ventrolateral tubercles. On the initial part of the body-chamber ribs tend to bifurcate, whereas on the apex bifurcation is only occasionally observed. The ribs are prorsiradiate on the spiral limb and radiate on the apertural limb. Ribs weaken on dorsal part of the body-chamber.

Since the investigated specimens show distinct size differences, height and breadth of whorl at the apex of body-chamber were measured in thirteen specimens. The apex has been chosen because the aperture is preserved only in two smaller pieces. Generally, the height/width ratio varies between 0·92 and 0·97. However, regarding absolute values of whorl height, apparently two groups can be distinguished: one with *wh*-values of 18 to 24 mm (five specimens), the other showing *wh*-values of 29 to 34 mm (seven specimens). One exceptionally large body chamber has a *wh* of 41 mm (Pl. 49, figs. 9 and 10).

Kennedy (1986, p. 95) reported dimorphism in *N.* (*Bostrychoceras*) *polyplocum* (Roemer, 1841), being expressed in distinct size differences of the body-chamber. This could also be the case in our material, but since the preservation of our specimens does not permit determination on the specific level, no final conclusions can be drawn.

The specimen figured on Plate 49, figs. 9 and 10 (largest specimen) very closely resembles that of Douvillé (1928, pl. 6, fig. 17) from Gebel Abu Had, a locality close to that of the present material, which he attributed to *B. polyplocum*. The medium-sized body-chambers of the present material resemble those of Antunes and Sornay's (1970, pl. 2) specimens, figured as '*N.* aff. *helicinum* (Shumard) Stephenson', but since the phragmocone of our material is unknown, it is impossible to decide whether they are conspecific.

Occurrence. Rakhiyat Formation: Unit 3 in section 1 (SFB C437–C447) and section 3 (SFB C448–C452). Late Campanian.

Subgenus PLANOSTOCERAS Lewy, 1967

Type species. Planostoceras rehavami Lewy, 1967, p. 168, pl. 4, figs. 1–4, by original designation.

Nostoceras (*Planostoceras*) sp.

Plate 49, figs. 6–8

Material. Fifteen fragments (SFB C454–C466). Six fragments of hook-shaped body-chambers, six fragments of phragmocone, the most complete of which is a cast of one and a half whorls, and three small fragments of the intermediate part between the phragmocone and the body-chamber. The suture line is only rudimentarily visible on one fragment. Dimensions could not be determined.

Description. The most complete part of phragmocone is characterized by a very low torticone spire, in which the whorls are only slightly touching. The ornamentation of phragmocone consists of fine dense ribs which

bear a pair of ventrolateral tubercles at irregular distances. Ribs weaken on the dorsal side. The fragments of body-chamber, which are V-shaped with a rounded base, differ slightly in size and density of ribs. The regularly spaced ribs are simple, first prorsiradiate, on the initial part of the body-chamber with a weak tendency to bifurcate, later radiate, and each bears ventrolateral tubercles. The aperture is slightly constricted on the flanks. No tendency for a change of the direction of coiling was observed in the most complete specimen.

Discussion. The present material very closely resembles the description and illustrations of *N.* (*P.*) *rehavami* Lewy, 1967 (pl. 4, figs. 1–4) from the late Campanian of the Negev with regard to the mode of coiling and ornamentation, but reaches only two-thirds of the size of Lewy's specimens. Since no complete specimen is present among the investigated material, due to the smaller size of our fragments and the differences of the phragmocone, the relation between the present material and *N.* (*P.*) *rehavami* is not clear.

Occurrence. Rakhiyat Formation: Unit 3, section 3. Late Campanian.

Genus SOLENOCERAS Conrad, 1860

Type species. Hamites annulifer Morton, 1842, p. 213, by original designation of Conrad (1860).

Solenoceras humei (Douvillé, 1928)

Plate 49, figs. 3 and 4

1928 *Ptychoceras humei* Douvillé, p. 37, pl. 6, figs. 9 and 10.
1929 *Ptychoceras* sp.; Picard, p. 436, pl. 9, fig. 2.
1967 *Solenoceras humei densicostata* Lewy, p. 170, pl. 3, fig. 4.
?1969 *Solenoceras* cf. *S. multicostatum* Stephenson; Lewy, p. 125, pl. 3, fig. 6.
?1969 *Solenoceras* cf. *S. reesidei* Stephenson; Lewy, p. 126, pl. 3, fig. 7.
1969 *Solenoceras* cf. *S. texanum* (Shumard); Lewy, p. 127, pl. 3, fig. 8.

Material. Two almost complete specimens (SFB C430, C468), twenty-three double-shafted fragments, and more than fifty single shaft fragments (SFB C467, C469).

Dimensions. In the most complete specimen (SFB C430) the young shaft is 62 mm long, preserved up to the outer part of the initial stage, and its adult shaft is 43 mm long. In a second, less complete specimen (SFB C468, see Pl. 49, fig. 4) the preserved part of the young shaft is 52 mm and the adult one 46 mm long.

Description. See Lewy (1967, p. 170).

Discussion. The present material, collected near the type-locality of *S. humei*, consists mainly of internal moulds in different stages of preservation. The suture line is not preserved. Within the association of *Solenoceras* the specimens attributed to *S. humei* show a considerable variation in size and ornamentation; height and width of the cross-section of the adult shaft are almost equal. Almost regardless of the size the density of the ribs varies between four and eight per centimetre at the same growth stage. Although a tendency is observed for extremely small specimens always to show dense ribbing, we assume that the subspecies *S. humei densicostata* Lewy, 1967 is a large, densely ribbed form within the variability of *S. humei*.

Occurrence. Rakhiyat Formation: Unit 3, section 1 (SFB C467–C468, C430) and section 3 (SFB C469). Late Campanian.

The species is known from the late Campanian of the Middle East (Lewy 1967).

CONCLUSIONS

The study of ammonites from the Wadi Qena area contributes to knowledge on the late Cretaceous transgressive/regressive history of south-eastern Egypt. Since a recent compilation of palaeontological, micropalaeontological, and palynological data from the Mesozoic to Palaeogene

strata of southern Egypt regarding the transgressive/regressive cycles has been published by Luger and Schrank (1987), only a brief discussion on the late Cretaceous shall be given here.

In the Wadi Qena area the lowermost sedimentary unit (Wadi Qena Formation, ?Albian/early Cenomanian) is characterized by continental deposits. Here the first transgression lasted from the late Cenomanian to the early Turonian (Galala Formation, sea-level highstand probably during the latest Cenomanian). A regressive period thereafter is characterized by continental deposits (lower Umm Omeiyed Formation). During the late Turonian another minor transgression took place (upper Umm Omeiyed Formation). Subsequently, in the early Coniacian, a return to continental sedimentation is observed (lower regressive sequence of Hawashya Formation). In the mid- to late Coniacian a new transgression invaded eastern Egypt (lower transgressive sequence of Hawashya Formation) and reached further south than the preceding ones (Luger and Schrank 1987). The Santonian to early Campanian here is characterized by a regressive/transgressive/regressive development (upper Hawashya Formation); the age of the marine transgression remains uncertain since as yet no guide fossils have been found in the southern Wadi Qena. During the late middle Campanian a new transgression took place (uppermost Hawashya Formation and basal Rakhiyat Formation). Interrupted by a minor regressive phase (unit 3 of Rakhiyat Formation, see Hendriks and Luger 1987), a sea-level rise is again observed in the late Campanian (unit 4 of Rakhiyat Formation, see Hendriks and Luger 1987). A short, but prominent, regressive period during the latest Campanian/earliest Maastrichtian is indicated by a hiatus between the Rakhiyat and the Dakhla Formations in the Eastern Desert (Hendriks and Luger 1987). During the late early Maastrichtian (base of Dakhla Formation in the Eastern Desert) a major transgression started in Egypt which, interrupted only by minor regressive tendencies, lasted until the early Eocene (see Luger 1985; Luger and Schrank 1987).

The transgressive/regressive cycles of southern Egypt show remarkable correspondence with those of other cratonic areas as expressed in the eustatic curves of Haq *et al.* (1987, fig. 3). The late Cenomanian/earliest Turonian transgression in Egypt clearly corresponds to cycle UZA 2.5 TR/HS, the late Turonian to cycle UZA 2.7 HS, and the mid or late Coniacian to cycle UZA 3.1. The late middle Campanian transgression probably corresponds to cycle UZA 4.2 (referred to as early late Campanian in Haq *et al.*, ibid.); the late Campanian to Maastrichtian development corresponds to eustatic cycles UZA 4.3–UZA 4.5. The eustatic cycles UZA 2.6 (middle Turonian) and UZA 3.2–UZA 4.1 (Santonian to early Campanian) are not recognizable in the sedimentary succession of southern Egypt (see also Klitzsch 1986; Hendriks *et al.* 1987). These deviations from the eustatic cycles may indicate that the transgressive pulses were only of minor importance and did not reach the investigated area. However, it seems more likely that they are related to major regional tectonic movements, e.g. extensive faulting and formation of Graben systems in the Aswan–Abu Simbel area (Hendriks 1987, p. 150) or folding of the Syrian Arc System (Schandelmeier 1988, p. 105). In contrast the times of cycle coincidence represent phases of relative tectonic stability in south-eastern Egypt.

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PETER LUGER
Technische Universität Berlin, SFB 69
Aekerstraße 71–76
1000 Berlin 65

MANFRED GRÖSCHKE
Institut für Geologie und Paläontologie
Teehnisehe Universität Berlin
Ernst-Reuter-Platz 1
1000 Berlin 12

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